IS YANG STYLE TAI CHI A "ONE SIZE FITS ALL" FALL PREVENTION EXERCISE PROGRAM FOR OLDER ADULTS?

Investigating Yang style tai chi and its influence on physical function and fall prevention among older adults

by

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A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

Masters of Health Sciences

in

The Faculty of Health Sciences Graduate Studies Program

University of Ontario Institute of Technology
Oshawa, Ontario

August, 2011

INVESTIGATING YANG STYLE TAI CHI AND ITS INFLUENCE ON PHYSICAL FUNCTION AND FALL PREVENTION AMONG OLDER ADULTS

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ABSTRACT

Falls among Canadian older adults is a growing problem, not only in terms of incident rates and its impacts, but most importantly, the vast scope of preventable morbidity and mortality. A decline in age-related physical function is acknowledged as a risk factor of falls. Community-based group exercise programs such as Yang style tai chi may help to reduce fall risk by improving components of physical function. To investigate, a pretest-posttest experimental design was conducted. Post-intervention assessments revealed Yang style tai chi practiced three times a week over eight weeks improved balance, muscle strength and muscle endurance. These findings suggest Yang style tai chi is moderately effective in reducing fall risk but further research is needed to determine the true effectiveness of tai chi as a fall prevention strategy. This study provides directions for future research guided by a proposed conceptual framework and offers some tentative recommendations for community health practice.

Key Words: older adults, exercise, physical function, falls, tai chi

ACKNOWLEDGEMENTS

I would like to thank my research supervisor Dr. Manon Lemonde for all the time, support, and guidance provided. She has continuously encouraged me to persevere and was one of the few who believed in my research objectives from the beginning. I thank my committee members Dr. Paul Yielder and Dr. Mikael Eklund for their input and support, especially their help in identifying resources when needed and providing exceptional feedback during the writing process. Also a special thanks to Bill Goodman and Arsalan Afzal for taking time to review my statistical analysis. Furthermore, I would like to recognize and express gratitude to the Research Institute of Aging, specifically Susan Brown for the assistance in organizing pre-assessment schedules, and a sincere thank you to the Village of Taunton Mills for the use of their facility, willing staff and residents. Finally, I want to express my appreciation to my family, Dad, Mom, Didi, Mel and Lorraine, thank you for your support, love and understanding throughout my thesis journey.

This would not have been possible without you all, Thank You!

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LIST OF ABBREVIATIONS

BBS	Berg Balance Scale
BMI	Body Mass Index
CBR	Community Based Research
CPF	Composite 12-item Physical Function Scale
CSR	Chair Sit-and-Reach
FFF	Functional Fitness Framework
PAR-Q	Physical Activity Readiness Questionnaire
RFMF	Risk Factor Model for Falls in older age
SFT	Senior Fit Test
6MW	Six-Minute Walk
30-SCS	Thirty Second Chair Sit-and-Reach
TUG	Timed Up-and-Go

CHAPTER 1

INTRODUCTION

1.1. Statement of problem

One of the most distinctive demographic events of the 20th and 21st centuries is population aging (Anderson & Hussey, 2000; Pigott, 2002; Turcotte & Schellenburg, 2006). Population aging is defined as a process by which *older adults* become a proportionally larger share of the total population (Pigott, 2002). The World Health Organization (WHO) states the number of older adults (considered those 60 years and above) is growing faster than any other age group (WHO, 2007). In Canada between 1981 and 2005 the older adult population nearly doubled from 2.4 to 4.2 million, increasing their distribution in the total population from 9.6% to 13.1% (Turcotte & Schellenburg, 2006). From 2006 to 2050, the total number of older adults is projected to increase from 688 million to approximately two billion worldwide (Kinsella & Velkoff, 2001; WHO, 2007). These numbers are expected to increase over the next three decades, particularly as individuals from the demographically labelled Baby Boomer generation (those born between 1946 and 1965) turn 65 years of age. In the 2006 Canadian census, Baby Boomers accounted for the largest proportion of the total population at 68.6% (Statistics Canada, 2007). This proportion will influence the Canadian older adult population to reach 9.8 million by 2038, further increasing their share of the total population to an astounding 24.5% (Statistics Canada, 2007; Turcotte & Schellenburg, 2006).

Tideiksaar (1997) suggests one of the most significant health challenges to population aging is the act of falling among older adults. Furthermore, the WHO acknowledges it will be critical to address fall prevention because, if the current state of falls among older adults remains unchanged, confounded by the influence of an aging population, the magnitude and impact of falls will rise exponentially (WHO, 2007). A *fall* is defined as an unintentional change in position resulting in an individual landing at a lower level such as on an object, the floor or the ground, with or without injury (Hauer, Lamb, Jorstad, Todd, & Becker, 2006; Public Health Agency of Canada [PHAC], 2005). Notably, falls have been identified as one of the major causes of morbidity and mortality in older adults (PHAC, 2005). Approximately one third of generally healthy, community living, older adults fall annually (American Geriatrics Society et al., 2001; PHAC, 2005). In 2008, this translated into approximately 1.5 million Canadian older adults who fell at least once (Scott, Wagar, & Elliot, 2010). Almost half of older adults who fall experience a minor injury, and 5% to 25% sustain a serious injury (Division of Aging & Seniors [DAS], 2007) which often requires hospitalization (Registered Nurses' Association of Ontario [RNAO], 2002) and may ultimately lead to death (DAS, 2007). In Canada, falls are the sixth leading cause of death for older adults (RNAO, 2002) and in Ontario alone, it is estimated that every 20 minutes at least one older adult visits the emergency department due to a fall (Ontario Injury Prevention Resources Centre [OIPRC], 2007), making falls a leading cause of injury admission in the province's acute care hospitals (PHAC, 2005).

Aside from the consequences of fall-related morbidity and mortality rates, there are other direct impacts to personal well-being of older adults, as well as to public health finances. In regards to personal well-being, falls have been associated with reduced quality of life, decreased independence, and loss of self-confidence, often resulting in psychological trauma and/or contributing to further falls (PHAC, 2005). In regards to public health finances, falls account for $2.9 billion annually among Canadian older adults (DAS, 2007). These costs will significantly increase considering the expected population growth, as it is estimated that by 2031 approximately $4.4 billion will be spent on healthcare costs for falls and fall-related injuries among older adults alone (Scott et al., 2010). A 20% reduction in falls would translate to 7,500 fewer hospitalizations, leading to an annual national saving of $138 million (PHAC, 2005). Therefore, reduction of falls through prevention by minimizing *fall risk factors* becomes fundamental, as it would reduce rates of morbidity and mortality, enhance quality of life and personal independence, and decrease the associated financial burden to Canada's healthcare system.

1.2. Risk factors of falls and fall-related injuries

Falls in older adults are often precipitated by a number of factors. These factors encompass intrinsic (i.e. internal) factors such as age-related physiological changes and/or medication use, and extrinsic (i.e. external) factors such as environment hazards and/or footwear. A falling incidence may be viewed as a nonspecific sign or symptom representative of an underlying problem that can be attributed to either intrinsic or extrinsic events. In order to better understand the complexities of factors, the WHO developed a conceptual framework, "*Risk Factor Model for Falls in Older Age*" [RFMF] (see Figure 1 in Appendix A) that identifies four internal and external risk factors which is as follows:

- biological/physical (e.g. reduced balance resulting from advanced age)

- socio-economic (e.g. low income)
- behavioural (e.g. lack of exercise)
- environmental (e.g. poor building designs)

The RFMF is significant because it captures the four categorized risks of falls while further demonstrating the complexity and multitude of determinants that directly and indirectly affect health among older adults (e.g. advanced age and its association to a decline of physical function).

1.3. Approaches in reducing risk factors of falls and fall-related injuries

As a result of the complexity and multitude of fall determinants, effective approaches for fall prevention become important to address. The approaches to reduce fall-related risk factors can be categorized under two main interventions:

1. Single interventions (stand-alone strategies) such as modifications to the environment (e.g. laying down a non-slip surface such as a carpet), medication optimization (e.g. reduction of medication that alters equilibrium, causing dizziness), education (e.g. providing educational classes to increase knowledge regarding fall risks and preventative measures), and participation in exercise programs (e.g. taking part in fall prevention exercise classes in order to improve physical function).
2. Multi-factorial interventions, which considers the inclusion of two or more single-intervention strategies (e.g. education and medication optimization).

Campbell & Robertson (2007) demonstrate that there are no discrepancies between approaches used, as single interventions or stand alone strategies (e.g. group-based exercise programs) delivered to community-dwelling older adults have proved to be as effective in reducing falls as programs with multiple interventions (e.g. education and group-based exercise programs). Although either approach may be effective, the reduction of fall risk factors through these approaches can pose challenges. These challenges exist through the interaction of risk factors resulting in high financial expense and difficulties in modification and implementation. For example, poor stair design (an environmental risk factor) can be difficult to modify when limited by low income (a socio-economic risk factor). Although challenging, a proven cost-effective and easily modifiable approach in reducing fall risk factors is stand-alone exercise interventions (e.g. tai chi exercise classes) (Campbell & Robertson, 2007; Carter, Kannus, & Khan, 2001; Tinetti & Williams, 1997). To clarify and provide a means for integrating the understanding of fall risk factors, lack of exercise (a behavioural risk factor of falls) and its potential influence on aspects of biological/physical risk factors such as poor balance can be modified through exercise participation (e.g. practicing group-based tai chi).

1.4. The relationship between exercise, physical function and fall prevention

Research shows that exposure and involvement in group-based exercise classes and, more importantly, the act of *exercising* is an effective intervention for preventing and reducing falls among older adults (Brown, 1999; Chang et al., 2004; Gillespie et al., 2001, 2003, 2009; Rose, 2008; Sherrington et al., 2008). Exercise is defined as a subset of *physical activity* that is planned, structured, repetitive, and purposeful (Caspersen, Powell, & Chritenson, 1985). Physical activity is understood as any bodily movement produced by skeletal muscles that result in energy expenditure (Caspersen et al., 1985). A primary objective of exercising is to improve or maintain one or more components of physical fitness[1] (Caspersen et al., 1985). Being physically fit as Caspersen et al. (1985) suggest, is conceptually understood as the ability to carry out Activities of Daily Living (ADL) with sufficient energy and without fatigue or pain especially when met with unforeseen emergencies (e.g. experiencing a fall). In addition to its objective (i.e. improve or maintain one or more components of physical fitness), exercise among the older adult population improves quality of life (Vaapio, Salminen, Ojanlatva, & Kivela, 2008), enhances physical function (Cochrane, Munro, Davey, & Nicholl, 1998) and cognitive performance (Brown, Liu-Ambrose, Tate, & Lord, 2008), and reduces the risk of depression (Strawbridge, Deleger, Roberts, & Kaplan, 2002). However, clarifying the question: why is exercise an effective intervention in preventing falls? still remains elusive.

As understood by the RFMF (WHO, 2007) (refer to Figure 1 in Appendix A), as older adults age they experience declines in physical capacity (considered as a biological risk of falls). Seeman & Chen (2002) and Garber et al. (2010) further support this by stating, as older adults age they experience declines in physical function. It is important to note that the term *physical capacity* and *physical function* are used interchangeably (as stated in PHAC, 2005 and WHO, 2007) because both terms encompass performing ADL which is influenced by age-related biological/physical components such as balance (i.e. having a higher level of functional balance will aid in better performing ADL). According to Bruce et al. (2009), physical function is defined as the ability to perform

[1] Similarly, Merriam-Webster's Dictionary (2010) defines exercise as "bodily exertion for the sake of developing and maintaining physical fitness".

ADL to more vigorous activities that require increasing degrees of mobility, strength and/or endurance. This definition of physical function is similar to Caspersen et al.'s definition of physical fitness as both terms incorporate the ability to perform ADL. Although Caspersen et al. extend the definition by adding ADL performed with sufficient energy and without fatigue, it is important to acknowledge that without energy and with fatigue one would not be able to perform ADL. As a result, the terminology, *physical function* will be used to encompass both physical capacity and physical fitness.

According to Caspersen et al., physical function is influenced by key components being body composition, cardio-respiratory (aerobic) endurance, muscular endurance, muscular strength, flexibility, agility, balance (static and dynamic), coordination, speed, and power. It is suggested that components of physical function are synonymous with types of biological/physical risk factors associated with falls (Sherrington et al., 2008; WHO, 2007; PHAC, 2005). This understanding offers a potential index of normal body states that when altered may indicate or predicate the possibility of a fall which leads to the potential use of these indices in a purpose designed fall risk measurement inventory. For example, LaStayo, Ewy, Pierotti, Johns, & Lindstedt (2003) demonstrate that a decline in a component of physical function such as lower body muscle strength increases the likelihood of falling. Similarly, Iwamoto et al., (2009) demonstrate that a decline in the physical function component of balance results in higher fall risk. It is evident among fall-related literature that components of physical function are influential in fall outcomes because they are relatively considered as biological/physical risk factors of falls. Sherrington et al. further suggest that a decline in physical function is comprised and influenced by a decrease of age-related components (e.g. balance decreased through aging process) which are further understood as biological/physical risk factors of falls. In addition, PHAC (2005) argues a reduction in an older adult's overall physical function can be reversed through participation in exercise, because the primary objective of exercising is to improve components of physical function (e.g. balance) that reduce the relative biological/physical risk of falling. Thus, exercise is asserted to be an effective intervention in preventing falls because its objective is to improve physical function through its components which result in a decrease of biological/physical risk factors that are key predictors of falls.

1.5. The rise of Canadian community-based group fall prevention exercise programs

From 1999 to 2000, the Canadian Federal/Provincial/Territorial ministers responsible for older adults created a strategic plan in recognition of the serious impact of falls (DAS, 2001). The strategic plan had three main objectives: (a) develop an inventory of programs designed to reduce falls across all provinces, (b) conduct a literature review to assess the effectiveness of fall-related initiatives, and (c) develop a fall prevention best practice guide for health care practitioners and policy makers. Objectives (b) and (c) of this strategic plan initiated the creation of a guide, "*A Best Practice Guide for the Prevention of Falls among Seniors Living in the Community"* (Scott, Dukeshire, Gallagher, & Scanlan, 2001) that provided evidence for effective approaches in preventing falls. The information presented in this report is based on guidelines, systematic reviews, and the author's research on fall risk factors and best practices for the prevention of falls among older adults (Scott et al., 2001). The fall-related literature used to support the report included: The Rand Report (Chang et al., 2004), American Geriatrics Society Guidelines (American Geriatrics Society et al., 2001), and Cochrane

Reviews (Gillespie et al., 2001; McClure et al, 2005). Scott et al.'s (2001) report recommended a community-based group exercise program as a best practice or approach to reduce fall risk and therefore prevent falls because it is both cost-effective and easily modifiable which is similar to recommendations by previously stated literature (refer to section 1.3).

From 2003 to 2005, DAS completed their strategic plan by developing an inventory of public health intervention programs designed to reduce falls (objective (a) of the aforementioned strategic plan). The inventory provided a snapshot of fall prevention programs used as a public health strategy among ten provinces (Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, Quebec, and Saskatchewan) across Canada. The results demonstrated 174 fall prevention programs are in existence and, of those approaches, 86 (nearly 50%) are community-based group fall prevention exercise programs specifically for those *independently living*[2]. Although the results of the inventory demonstrate that exercise interventions such as tai chi practice used as a preventative public health strategy among those independently living in the community are well in existence (DAS, 2001), the conclusion of the strategic plan suggests future research is needed because uncertainties exist in determining how to *optimize* exercise programs to prevent falls and determining which types of exercise programs are most *effective* for reducing falls. This would better justify the exercise program's use as a fall prevention strategy.

1.6. Study aim, structure and summary

An approach to resolve how to *optimize* an exercise program to prevent falls is by

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[2] Independently living is understood as living arrangements where there is limited or no assistance with ADL (PHAC, 2005).

determining whether it targets all components of physical function, as improving all components would have greatest effect on reducing the biological/physical risk factors of falls. Furthermore, by comprehensively targeting components of physical function, it will help better determine which types of exercise programs are most effective for reducing falls. However, there is inadequate evidence to date to determine whether exercise interventions target all components of physical function while considering the prevention of falls. Although there is extensive literature on exercise interventions that target specific components such as balance to help reduce falls, further analysis on other components is needed to provide a better insight into the effects of an exercise program on physical function and fall prevention (Gillespie et al., 2009). It becomes critical to achieve this insight especially as Gillespie et al.'s (2009) research suggests exercise programs targeting multiple physical function components achieved a statistically higher significance in reducing the rate and risk of falling when compared to those exercise programs that did not. Therefore, the conceptual aim of this study is to report on the relationship between factors that influence a selective exercise program on the multi variable components of physical function and its relationship to fall prevention among independently living older adults. Contextually, the study sets out to report the various ways in which these components have been examined to date. Specifically, the study sets out to determine and evaluate a selected purpose-designed exercise protocol adopting a twofold approach.

In the initial stage of the study, a comprehensive literature review was conducted to clarify four essential themes concerning fall prevention programs experienced by independently living older adults based on the following questions:

1. Are community-based group exercise programs beneficial in improving components of physical function while preventing falls?
2. What components of physical function do exercise programs target to prevent falls?
3. What types of existing community-based group exercise programs are used to prevent falls?
4. Of these existing fall prevention exercise programs, which is the most common/frequent?

After the literature review has been completed and the most common fall prevention exercise program identified, this program will be evaluated – in practice as experienced by a group of male and female older adults aged 60 years and above. Specifically, after the literature review has been conducted and the most common fall prevention exercise program for evaluation has been identified, an experimental design (to be further discussed in Chapter 3) will be used to test this *preliminary hypothesis*: a fall prevention exercise program practiced by older adults aged 60 years and above will (a) improve physical function (consisting of its components which is to be confirmed by the literature review), and improved components of physical function will accordingly (b) reduce the biological/physical risk of falling. By testing this hypothesis, it will help better answer the following research question:

- Does the identified fall prevention exercise program influence all or specific components of physical function which theoretically lowers the biological/physical risk factors (key predictors) of falls?

It is expected that this approach will initiate determining which types of exercise interventions are most effective for reducing fall risk and, furthermore, it will aid in determining the profile of an optimal fall prevention exercise program.

To summarize, Chapter 1 was concerned with the (a) the impact of the problem and (b) the influences an exercise program has on physical function which comprise of its components that have further been understood as key predictors of falls. It is anticipated that this study will contribute to our understanding of how an existing exercise program is capable of optimally reducing all biological/physical risk factors of falls thereby profiling and confirming its status as an optimal fall prevention exercise program. It is now important to further define the phenomenology of the selected program, its design, application and current relevance as represented in the literature. Therefore Chapter 2 will build on concepts presented in Chapter 1 by providing a most recent review of supporting literature and furthermore discussing specific aims. Chapter 3 will explain the study's method which provides details about the sample, data collection, and analysis used. Chapter 4 will present the findings. Chapter 5 will review and discuss the findings to relevant theory, explain study limitations, as well as provide recommendations for future research and for community health practice. Chapter 6 will conclude the study and reflect on its significance. It is important to note the organization of these chapters *reflects the* *journey (in occurrence)* taken to initiate, develop, implement, analyze, discuss and conclude this study.

CHAPTER 2

LITERATURE REVIEW

As demonstrated in Chapter 1, a variety of community-based fall prevention exercise programs (stand-alone strategies) are established in Canada among independently living older adults. However, future research is needed because uncertainties exist in determining which types of exercise programs are most effective for reducing falls. This will inform how to optimize existing exercise programs to prevent falls. The effectiveness of a fall prevention exercise program can be determined by demonstrating whether the exercise reduces all biological/physical fall risk factors. To simplify, biological/physical risk factors will be referred to as *physical risk factors*. The reduction of physical fall risk factors (e.g. reduced flexibility, reduced balance, etc.) can be verified by the exercise program's influence on improving components of physical function (e.g. balance, muscle strength, etc.) that have been demonstrated to decrease as a result of aging. Hence as an example, the reduction of a physical risk factor such as balance can be evidenced by the exercise program's influence on improving balance as a component of physical function. With this being understood an exercise program that improves components of physical function demonstrates a way of optimizing the exercise program by reducing the associated risk of falls and therefore aids in falls prevention. Such evidence is essential to determine whether an exercise program targets the components of physical function associated with the prevention of falls.

For organizational purposes, the literature review has been divided into four distinct parts:

1. *Search strategy and selection criteria*: demonstrates how documents were retrieved for the literature review.

2. The description of a *conceptual framework*: developed to explain the relationships between the processes of aging, physical function, exercise and falls.

3. Establish the *gaps and inconsistencies of key identified variables*: as components of physical function and exercise related to falls, this section includes research questions previously mentioned and established from the literature review (refer to p. 11).

4. *Summary*: review the gaps and inconsistencies of the literature reviewed, and discuss the aims of the study.

2.1. Search strategy and selection criteria

A two-step literature search was conducted from October 2009 to February 2010. The initial search sought out published systematic reviews from January 2004 to January 2010 to advance knowledge and obtain further key search words. Two primary search databases were used: Centre for Reviews and Dissemination (CRD) and Cochrane Collaboration (CENTRAL) review. A basic keyword search was established based on the researcher's prior knowledge on the topic. The words "fall", "prevention", "exercise", "elderly" and "community" were used interchangeably with the Boolean operators (AND,OR) in both databases. In addition, the key word "elderly" was replaced with "seniors" and "older adults" to ensure the target audience was captured. A total of seven systematic reviews were selected (Chang et al., 2004; Gillespie et al., 2001, 2003, 2009;

Sherrington et al., 2008; Verhagen, Immink, Van der Meulen, & Bierma-Zeinstra, 2004) based on the title and determined likely to be relevant for review.

After evaluating retrieved systematic reviews, a second search was conducted to ensure the inclusion of as many relevant reputable published documents for review. A total of three internet search strategies were used which included: (a) database searches (Pubmed, Proquest, Medline (OVID), Web of Science) to obtain scholarly articles, (b) internet searches (www.phac-aspc.gc.ca, www.collectionscanada.gc.ca/thesescanada, www.gov.ns.ca, www.hc-sc.gc.ca,) to retrieve Canadian statistics and grey literature, and (c) manual checks of document references. Based on the initial systematic review search, the same key words (refer to p. 15) were used separately and interchangeably with Boolean operators (AND, OR) and repeated in each database to ensure consistency. The titles and abstracts (when provided) of documents were read and if relevant to the topic were considered as relevant for review.

The initial search in identifying scholarly articles was based on a two-step selection process. First, using database searches as described above, a total of 56 studies were identified based on reading their title. Duplicate studies from the database search strategies were removed (n=10). Second, the abstracts of 46 studies that were identified in step one were read and screened based on specific inclusion/exclusion criteria. The inclusion/exclusion criteria consisted of the following: a sample population of older adults aged 60 years and above, written in English only, recently published literature (from January 2004 to January 2010), a sample population considered as *healthy* (understood as the ability to cope with disabling conditions) and *independently-living* (understood as living arrangements where there is limited or no assistance with ADL), and stand-alone exercise interventions that target at least one component of physical function while incorporating fall prevention by stating it and/or by measuring the occurrence or risk of falls. This would help identify the exercise interventions as a fall prevention exercise program and moreover, being selective of the sample population as healthy and independent older adults, strengthen internal validity (to be discussed in Chapter 3, section 3.2). As a result of the inclusion/exclusion criteria, a total of 13 scholarly articles (Ballard, McFarland, Wallace, Holiday, & Roberson, 2004; Freiberger, Menz, Abu-Omar, & Rutten, 2007; Iwamoto et al., 2009; Li, Harmer, & Fisher, 2005; Lin, Hwang, Wang, Chang, & Wolf, 2006; Logghe et al., 2009; Means, Rodell, & O'Sullivan, 2005; Shumway-Cook et al., 2007; Skelton, Dinan, Campbell, & Rutherford, 2005; Suzuki, Hunkyung, Yoshida, & Ishizaki, 2004; Voukelatos, Cummings, Lord, & Rissel, 2007; Weerdesteyn et al., 2006; Woo, Hong, Lau, & Lynn, 2007) were retained for data extraction and analysis. The search strategies for both systematic reviews and scholarly articles were reviewed for consistency. For further clarification, see Table 1 in Appendix B for complete inclusion/exclusion criteria. In addition, results of the literature search (for systematic reviews and scholarly articles) are organized in a step-by-step flow chart (see Figure 2 in Appendix B).

2.2. Conceptual framework

Polit & Beck (2008) define a *conceptual framework* as “Interrelated concepts or abstractions assembled together in a rational scheme by virtue of their relevance to a common theme” (p. 748). This broadly relates to the principles involved in improving the components of physical function to reduce physical fall risks through exercise participation, a theme presented in Chapter 1. Interrelated concepts include the process of a decline in age-related physical function, components of physical function, and exercise participation. In order to accurately define and standardize the components of this theme, a pre-defined conceptual framework and/or model was searched for in the literature. This proved challenging and elusive as there was a paucity of authorship demonstrating the relationship between the identified concepts and the related themes. Although the preliminary conceptual frameworks retrieved yielded valid information in relationship to specific concepts such as (a) mobility, behaviour, fall risk factors and physical environment (Feldman & Chaudhury, 2008), (b) physical activity, physical fitness and morbidity/mortality outcomes (Kahn et al., 2002) and (c) fall risk factors (including lack of exercise) and aging (Nova Scotia Health Promotion and Protection, 2007), it failed to clearly demonstrate the comprehensive relationship between *all concepts of inquiry* and hence support the research process. It became vital to demonstrate all concepts of inquiry in a defined conceptual framework in order to better illustrate interrelated concepts and further investigate and justify a paradigm of the phenomena. Therefore, a conceptual framework was created by merging two frameworks:

(a) RFMF (WHO, 2007) (as seen in Appendix A)

(b) Functional Fitness Framework (FFF) (Rikli & Jones, 1997, 1999a) which was previously developed from Nagi's disability framework (Nagi, 1965, 1991)

As demonstrated in Chapter 1, RFMF was presented in a recent 2007 report, "*WHO Global Report on Fall Prevention in Older Adults"*, to provide a better understanding of risk factors related to falls and fall-related injuries (WHO, 2007, p. 5).

The RFMF was also selected as its related concepts supported the aforementioned conceptual frameworks retrieved (Feldman & Chaudhury, 2008; Kahn et al., 2002; Nova Scotia Health Promotion and Protection, 2007) as well as for its comprehensible integration of themes relating aging, physical function and exercise to fall prevention. This risk factor model is also broadly similar to the one developed by the Federal/Provincial/Territorial Committee of Officials for the Canadian Division of Aging Seniors (DAS, 2001) and re-confirms that fall-related risk factors comprise four parts: (a) environmental risks, (b) socio-economic risks, (c) behavioural risks, and (d) physical risks. Although multi-factorial fall risks are identified, the fall-related risk factors when considering interrelated concepts such as the process of aging, exercise participation, and the components of physical function, include behavioural (e.g. lack of exercise participation) and physical risk (e.g. declines in physical function components due to the process of aging).

Rikli & Jones (1997) created the FFF to identify key components of physical function required for the performance of various ADL. The framework was later updated by these authors to include body composition as it was argued to have a possible affect on other components of physical function which in turn influences the performance of ADL (Rikli & Jones, 1999a). The key components of physical function identified by Rikli & Jones are similar to Caspersen et al.'s components of physical fitness (as demonstrated in Chapter 1) being body composition, muscle strength, muscle endurance, aerobic endurance, flexibility, and mobility involving balance, coordination, speed/agility, and power (see general definitions of physical function components in Table 2 of Appendix C). Rikli & Jones (2001) argue that declines in these components are able to be modified through exercise interventions as lack of exercise involvement and/or participation is recognized to be a behavioural risk factor for falls and fall-related injury (WHO, 2007; DAS 2001). From these reported themes and to consolidate the relationship of deficits in physical function as a predictor and behavioural component of physical risk related to the incidence of fall, the models FFF and RFMF have been merged (by the relationship as expressed by a dotted line in Figure 3 found in Appendix D). Based on this merger, a "*Fall-related Physical Function Framework*" has been created (see Figure 4) to better illustrate the relationship of falls and risk in this study.

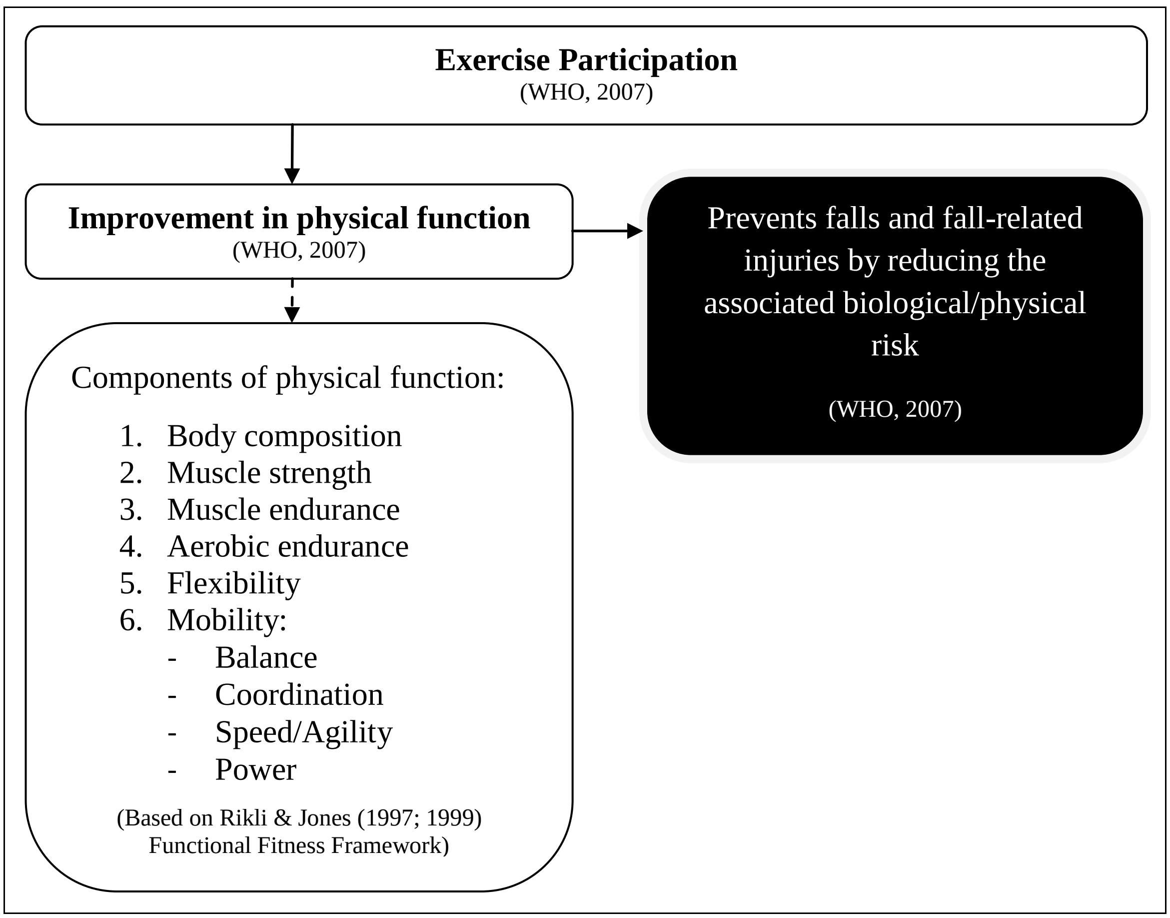

Figure 4. Fall-related Physical Function Framework which has been created through the adaptation of Risk Factor Model for Falls in older age (WHO, 2007) and Functional Fitness Framework (Rikli & Jones, 1997; 1999).

To summarize, the developed "*Fall-related Physical Function Framework*" considers that exercise participation improves physical function (through improvements of its components) which in turn reduces the associated physical fall risk and therefore aids in the prevention of falls and fall-related injuries. It is suggested, therefore, that this framework demonstrates the comprehensive relationship and synergies between all concepts of inquiry and is a valid foundation and component to this research process.

2.3. Gaps and inconsistencies of key identified variables

The gaps and inconsistencies of key identified variables emerged from clarifying four essential themes which are based on the following identified questions:

2.3.1. Are community-based group exercise programs beneficial in improving components of physical function while preventing falls?

The reviewed literature provided mixed evidence of whether community-based group exercise programs are beneficial in improving components of physical function while preventing falls. The findings did indicate that 11 out of the 13 studies retrieved (Ballard et al., 2004; Freiberger et al., 2007; Iwamoto et al., 2009; Li et al., 2005; Lin et al., 2006; Means et al., 2005; Shumway-Cook et al., 2007; Skelton et al., 2005; Suzuki et al., 2004; Voukelatos et al., 2007; Weerdesteyn et al., 2006) demonstrated exercise as beneficial by significantly improving a component of physical function, however, only six of these studies (Freiberger et al., 2007; Iwamoto et al., 2009; Li et al., 2005; Means et al., 2005; Suzuki et al., 2004; Weerdesteyn et al., 2006) reported a statistically significant difference in preventing falls by reducing the associated risk (reducing incident rate or hazard ratio of falls). In the reviewed literature, 46% of community-based group exercise programs involving independently living older adults improved at least one component of physical function (reducing physical fall risk) while reported as significantly preventing falls. A table has been developed to summarize these results (see Table 3 in Appendix E). The variability in the reported results may be attributed to (a) disparities in the manner falls are defined and measured and (b) varied duration of the exercise programs and compliance rates (or dropouts). These inconsistencies may also be attributed to inconsistencies in the remaining components of the literature review research. These inconsistencies pose the following questions: what components of physical function (physical risks) do exercise programs target to prevent falls; what types of existing community-based group exercise programs are used to prevent falls; and of these existing fall prevention exercise programs, which is the most common/frequent?

2.3.1.1. Disparities in the way falls are defined and measured

As an initial step in designing, implementing and analyzing an exercise intervention for fall prevention, it is essential that a definition of a fall is clearly stated and understood as a form of standardization among all stakeholders (i.e. participants, instructor, researcher, etc.). Of the 13 scholarly articles retrieved, four (Ballard et al., 2004; Iwamoto et al., 2009; Suzuki et al., 2004; Woo et al., 2007) did not provide a definition of a fall. The lack of defining a fall is problematic because it allows older adults to construe the word “fall” in various ways particularly when considering self-reporting. For example, Ballard et al. (2004) asked their sample population, “Have you fallen since the end of the research study last year?” and followed up by asking, “How many times have you fallen?” (p. 260). The results showed that all participants in the exercise group (as compared to a control group) reported no falls. Although this seems beneficial to the results of the overall study, one must question the researchers’ approach as they did not provide their study participants with a definition. This allows the study participants to define a "fall" by their own personal interpretations. These interpretations are dependent on their own judgements, experience, and knowledge of what a fall is, which can vary between all participants. Therefore, the study participants may or may not report an actual "fall" if their understanding of a fall differs from that of the researcher which may ultimately result in underreporting because the study participants may not clearly understand what they are being asked to report. The aspect of underreporting has the potential to compromise and weaken the validity and reliability of studies comparing fallers to non-fallers which was indentified among all reviewed literature (n=4) that did not define a fall.

In contrast, the remaining studies (Freiberger et al., 2007; Li et al., 2005; Lin et al., 2006; Logghe et al., 2009; Means et al., 2005; Shumway-Cook et al., 2007; Skelton et al., 2005; Voukelatos et al., 2007; Weerdesteyn et al., 2006) stated a definition of a fall. Although a common liberal definition of a fall was stated as, "coming to rest on the ground or lower level", further additions to the definition may have directly influenced a study's results. This concern is highlighted by Skelton et al. (2005) stating slipping and/or tripping onto the ground are not considered a fall whereas Logghe et al. (2009) did not include this definition. As a result the former may be underreporting and the latter may have comparatively reported more occurrences of falls. It may be argued that Skelton et al. were specific by adding further descriptions. However, older adults who fall may use different language to describe a fall, such as slipping, stumbling, tripping, or loss of balance. Clarification becomes vital when reporting (in order to determine the effectiveness of the fall prevention exercise program) while also allowing for a better comparison between studies. Therefore, it is argued that the consideration in use of an overall definition of a fall is impractical but when language and understanding are clarified it may become more realistic among stakeholders and would better identify and report fall incidences.

Similarly, difficulties occur when studies define a fall as coming to rest at a lower level but the description of the level varies. Some studies (Li et al., 2005; Logghe et al., 2009; Shumway-Cook et al., 2007) counted a fall if it resulted in body contact with the ground, the floor and objects including stairs, furniture and walls, as well as other supporting surfaces whereas the remaining studies did not describe the level and are assumed to report a fall only if the participant made contact with the floor or ground. The inclusion of different levels is important when attempting to capture the variations of falls, specifically non-injurious falls or near falls. The focus should be on reporting all aspects of a fall which can occur on various levels such as on an object as well as the ground, but was not captured among the majority of retrieved literature (n=10). Non-injurious falls or near falls have been predominantly disregarded among the literature as 7 out of 13 studies failed to include or *clarify* this variation and, in addition, one study (Lin et al., 2006) reported only injurious falls. The term *clarify* refers to the opportunity for participants to describe their fall. Giving the opportunity to clarify a fall allows the researcher to determine if the reported fall truly meets the definition of a fall or a *near fall*. Logghe et al. best defines a *near fall* as, “the person seems to fall, but can prevent it by catching or leaning on a person or a thing (e.g. chair, a drawer or a table)” (p. 71). The inclusion and mutual understanding of this definition is imperative because, if fall prevention is an objective of an exercise program, then recording warning signs such as non-injurious or near falls (in addition to injurious falls) is essential for the study's results. Therefore three categories have emerged which are: injurious falls, non-injurious falls and near falls. The inclusion and understanding of all three categories allows for a comprehensive depiction of the influence an exercise program may directly have on fall incidences and overall fall risk.

How a fall is measured is as essential as clearly defining a fall for demonstrating the effectiveness of a fall prevention exercise program. Although reporting systems were all classified as self-reporting, there was heterogeneity in the types of reporting systems used: a calendar, a diary, telephone interviews, face-to-face interviews, and record cards. It is important to determine the type of reporting systems used when considering confidentiality and anonymity because older adults may be reluctant to admit a fall due to the related social embarrassment (Kong, Lee, F., Mackenzie, & Lee, D, 2002) or the association that falling marks the transition to old age (PHAC, 2005). Moreover, having confidentiality and anonymity as a means of blinding is important to prevent performance and detection bias (Verhagen et al., 2004) (to be further described in Chapter 3).

There were two styles of self-reporting systems used: verbal accounts and written accounts. Verbal accounts collected by telephone or face-to-face interviews (a) were the least popular (based on frequency) as only 3 out of 13 studies used this approach and (b) had low *reporting*, where a summed total among studies (Ballard et al., 2004; Iwamoto et al., 2009; Lin et al., 2006) demonstrated only 95 fall counts from 490 participants (19%). Reporting is based on number of fall counts of each participant (post intervention) among the total number of participants. A potential reason for low reporting among studies that used telephone or face-to-face interviews is the lack in consideration of confidentiality and anonymity. For example, Lin et al. (2006) and Ballard et al. used a research assistant not blinded to the research to conduct telephone interviews (also a blinding method for the use of names was not mentioned), and Iwamoto et al. (2009) verbally asked (face-to-face) each participant whether they had fallen.

In contrast, studies that used a written account by calendar, diary, or record cards (a) were popular as 10 out of 13 studies used this approach and (b) had relatively higher reporting where a summed total among studies (Freiberger et al., 2007; Li et al., 2005; Logghe et al., 2009; Means et al., 2005; Shumway-Cook et al., 2007; Skelton et al., 2005; Suzuki et al., 2004; Voukelatos et al., 2007; Weerdesteyn et al., 2006; Woo et al., 2007) demonstrated 2269 fall counts from 2534 participants (90%). Although written accounts such as calendars, diaries, or record cards were popular and had high reporting, the consideration of confidentiality and anonymity was not clearly described. As a result, participants were assumed as not coded (not given an identification code to conceal their names) throughout the study. Therefore, to optimize written accounts as a reporting system, a refined approach that considers a way of blinding participants by using a coding system (identification codes) may be better suited to measure falls.

It is evident that (a) lack of defining a fall, (b) defining a fall with variation of descriptions or language and (c) inconsistent reporting systems (that lacked inclusion of confidentiality and anonymity measures) may diminish the reliability and validity of a study’s results, ultimately making comparisons between studies difficult. This may be a reason why different fall rates and their relationship to associated physical risks are reported among older adults that participate in exercise programs. Therefore if taking into account the gaps and inconsistencies presented by the way falls are defined and measured, a written account such as a calendar, diary or record cards that considers confidentiality and anonymity (by use of coding) with a clearly stated and understood definition as well as an opportunity to describe a fall (including near falls) as it occurs, is better suited to accurately record falls. This understanding aids in solidifying the essential and initial step in designing, implementing and analyzing an exercise intervention for fall prevention.

2.3.1.2. Duration of the exercise program and compliance rates

The duration of various exercise programs ranged from four weeks to twelve months. This inconsistency in duration of the exercise program influences compliance and dropout rates of participants which in turn affect the study's conclusions in determining the effectiveness of the exercise on fall prevention. For example, Li et al. (2005) conducted a six month study which began with 256 participants but lost 81 participants during tai chi exercise classes whereas Voukelatos et al. (2007) began with 353 participants but minimally lost six participants during tai chi exercise classes conducted over 16 weeks. Similarly, a customized exercise program that consisted of balance, gait and coordination conducted by Weederstyn et al. (2006) began with 113 participants and had a mere six participants drop out when conducting classes over a period of five weeks while still having significant findings (improving physical function and reducing fall risk). It is apparent that, among the older adult population, high dropout rates seem to increase due to an extended duration of an exercise program. As a result, shorter timeframes may be beneficial to eliminate dropouts, thereby increasing compliance and strengthening the results of the study. It is important to highlight the argument that dropouts may have occurred as a result of other factors other than duration and by the commonly understood reason of experiencing a fall but the majority of the literature did not capture reasons for dropout. Studies that did capture reasons for dropouts (Lin et al., 2006; Logghe et al., 2009; Shumway-Cook et al., 2007; Suzuki et al., 2004) which all stated duration as a factor, demonstrated the true effectiveness of an exercise program as it is understood that results of a study are strengthened by higher compliance rates. In addition, these studies acknowledged strength of its internal validity (exercise program) by demonstrating dropouts did not occur as a result of the exercise program but because of other factors such as physical inability to go to class (Lin et al., 2006), and transportation problems (Logghe et al., 2009). It is essential to capture reasons for dropout in order to (a) develop ways to increase exercise participation/compliance and (b) strengthen internal validity which ultimately affects the study’s results and conclusions.

2.3.2. What components of physical function (physical fall risks) do exercise programs target to prevent falls?

Among the articles retrieved for the literature review, exercise programs target a variety of specific physical function components as a result of their heightened physical fall risk. The inclusion of targeted physical function components was based on (a) measures (also understood as fall risk assessment tools) used or (b) whether the component was incorporated within the exercise. For example, Means et al. (2005) used the Functional Obstacle Course which is an assessment of speed, agility, and coordination and therefore the three targeted components as described were considered, whereas Skelton et al.’s custom exercise program incorporated balance, strength, endurance and flexibility exercises but did not assess measures of physical function and, as a result, the focus of the exercise program served as the inclusion of components. Furthermore, exercise programs among the scholarly articles retrieved indicated that components of physical function targeted among fall prevention exercise programs include one or multiple components as described in the *Fall-related Physical Function Framework* (see Figure 4, p. 20). Figure 5 was developed to better illustrate the results of retrieved studies that identified and therefore targeted physical function components among fall prevention exercise programs that aim to significantly reduce the risk of falls.

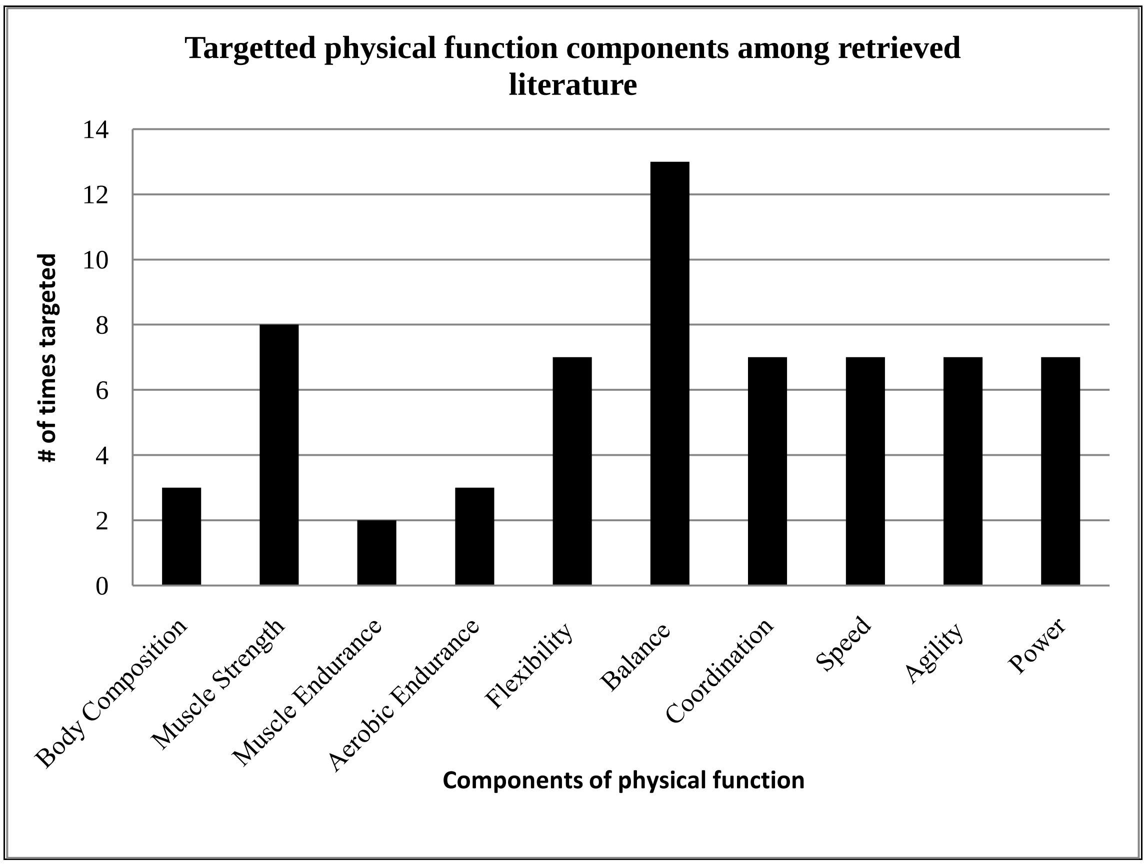

Figure 5. An illustration of the targeted physical function components reported to reduce the incidence and risk of falls among retrieved literature.

It is important to emphasize, of the studies that showed a statistically significant difference in reducing falls (Freiberger et al., 2007; Iwamoto et al., 2009; Li et al., 2005; Means et al., 2005; Suzuki et al., 2004; Weerdesteyn et al., 2006), all remained beneficial in improving at least one component of physical function. In addition, it is evident that balance became the highest identified and targeted component of physical function while being a homogenous target, as well as the most assessed component (assessed using multiple measures). However, the results of the studies were inconsistent. For example, Voukelatos et al. conclude tai chi exercise reduces the risk of falls by demonstrating improvements in balance, whereas Lin et al.'s results indicate tai chi improved balance but did not result in a significant reduction in falls. Moreover, Logghe et al. concluded that it is a possibility that the lack of balance improvement led to non-beneficial results of a tai chi exercise on falls while only testing for balance. All the aforementioned studies tested for balance which is one component of physical function and one physical risk predictor of falls. Although an improvement may be seen in balance, there may be a potential decrease in other components of physical function. The decrease in other physical function components such as flexibility may result in an increased physical risk of falls which may result in studies demonstrating a lack of fall prevention. For example, Lin et al. first identified balance as a physical risk of falls and, as a result, only assessed balance. Second, although Lin et al. demonstrated that balance improved, their exercise program (tai chi) did not significantly reduce (prevent) falls. The lack of statistical significance could be a result of the lack of improvement (and therefore lack in assessing) in other physical risk factors such as aerobic endurance. To compare, Suzuki et al. (2004) identified balance as well as flexibility as physical risks of falls and therefore assessed both components. The results of Suzuki et al. demonstrated that improvements in balance and flexibility resulted in significantly reduced falls. An imperative question arises: did Lin et al.'s tai chi exercise program fail to improve other physical risk factors of falls such as flexibility, resulting in the lack of reducing fall risk? An answer cannot be determined because Lin et al. failed to assess other physical risk factors of falls such as flexibility or muscle strength. Accordingly, this may have resulted in studies (Ballard et al., 2004; Lin et al., 2006; Shumway-Cook et al., 2007; Skelton et al., 2005; Voukelatos et al., 2007) that demonstrated improvements in at least one targeted physical function components but had no related significance in reducing/preventing falls. In contrast, body composition, muscle endurance, and aerobic endurance were the lowest targeted components. This may be a result of the lack of supporting research that identifies those components as physical risk factors of falls. However, these components are a part of physical function, and a loss of physical function has been identified as a physical risk of falls (DAS, 2001; PHAC, 2005; WHO, 2007). Based on this understanding, further questions arise: what effect does an exercise program have on other components of physical function and how do they influence fall prevention, and, furthermore, can an exercise program influence all components of physical function, therefore optimally and theoretically reducing all physical risk factors of falls as they relate to physical function?

If a fall prevention exercise program were to have the greatest effect in reducing the physical risk factors of falls it must focus on targeting all components of physical function which are: body composition, muscle strength, muscle endurance, aerobic endurance, flexibility, and mobility which includes balance, coordination, speed/agility, and power. However this goes beyond what has been specifically identified among the literature as it is evident that exercise programs considered targeting single (e.g. balance) or multiple variables (e.g. balance and flexibility) rather than focusing on all components of physical function. If the objective of an exercise program is to prevent falls by reducing physical risk factors which are understood as components of physical function, then it is essential to determine the influence of an exercise program on all these components. Therefore, it is important to emphasize that a theoretical assumption is being made (which is supported by the *Fall-related Physical Function Framework,* refer to p. 20): improvement in all physical function components may have the greatest effect on preventing falls because it reduces all identified physical risk factors of falls as they relate to physical function. This supposition is further supported by Gillespie et al.'s research which suggests exercise programs targeting multiple physical function components achieved a statistically higher significance in reducing the rate and risk of falling when compared to those exercise program that did not. Only two studies (Freiberger et al., 2007; Iwamoto et al., 2009) targeted a majority of physical function components, demonstrating significant improvements among the targeted components and significantly lowered physical risk of falls. Although Iwamoto et al. did not include aerobic and muscle endurance, and Frieberger et al. (2007) did not include body composition and muscle endurance, their understanding and approach of including many components of physical function allowed for a better portrayal of the effect of a fall prevention exercise program on overall physical function (as it relates to fall risk) and it demonstrates a better potential for comparative and influential relationships between physical risk factors of falls. In order to further understand this gap, to answer the aforementioned questions and to complete the preliminary hypothesis (refer to p. 12), it becomes important to identify what community-based exercise programs exist to prevent falls and, of the existing fall prevention exercise programs, which are the most commonly used among older adults.

2.3.3. What types of existing community-based exercise programs are used to prevent falls; and of these existing exercise programs, which is the most common /frequent?

The types of community-based exercise programs used to prevent falls among older adults varied across all studies. The variation in the types of exercise programs included one or a combination of the following areas: strength/resistance (e.g. weight lifting), balance (e.g. single leg stance), flexibility (e.g. stretching), gait or walking (e.g. stepping), as well as tai chi (e.g. controlled movements). Among the types mentioned, *tai chi* emerged as the most common community-based fall prevention exercise program. This is based on the results that 6 out of 13 studies retrieved (Li et al., 2005; Lin et al., 2006; Logghe et al., 2009; Suzuki et al., 2004; Voukelatos et al., 2007; Woo et al., 2007) incorporated tai chi exercise practice. A homogenous definition of tai chi emerged among the literature which stated tai chi as an ancient Chinese martial art consisting of a series of slow, low impact, and continuous movements. However, in order to gain a better understanding of tai chi and its influence on physical function and general well-being, supplementary literature was retrieved (Adler & Roberts, 2006; Klein & Adams, 2004; Masley, 1998; Sattin, Easley, Wolf, Chen, & Kutner, 2005; Verhagen et al., 2004; Wolf, Coogler, & Xu, 1997; Wu, 2002)

2.3.3.1. Emergence of tai chi

It became increasingly evident among the scholarly articles and literature retrieved that defining and understanding tai chi varies and the variations become exceedingly complex. The complexities emerge from the origin, history and philosophical roots (as variations are dependent on the creator) behind tai chi while attempting to comprehend key concepts such as “tao”, “chi”, “yin” and “yang”. For example, tai chi focuses on principles of yin yang, a Chinese philosophy that focuses on interdependent parts such as emotional/mental and physical balance that are part of a dynamic system that gives rise to each other. Though consistent of two parts, this study targets the physical dynamic through concerns of physical fall risks in an aging population. Although challenging to grasp, Wolf et al. (1997) best illustrates tai chi in the following citation:

> Practitioners of Chinese medicine believe that all elements in the universe are contained in a primordial, potential energy, known as Tao. Tao is believed to be a universal unifying principle from which emerged bipolar energy forces, called Yin and Yang...Imbalances in these energy forces are thought to produce physical dysfunction that may lead to poor health. Tai Chi (TC), also called Tai Chi Chuan, Tai Chi Quan, Taijiquan, or T'ai Chi, was devised more than 300 years ago in the late Ming and early Qing dynasties of China. Tai Chi, meaning "supreme ultimate," and Chuan, meaning "fist," was first perceived as a form of shadow boxing ~ and was subsequently transformed into a martial art in an effort to ward off foreign invaders or to suppress peasant insurrections (Chinese sports editorial board, 1986)...Throughout the positioning of a practitioner's pose, movement could be either energetic or gentle, with a slow, rhythmic harmony characterizing the rate of movement...It is designed to promote a smooth and balanced flow of energy throughout the body and has become popular among Chinese elders who wish to better control bodily movements and to be more

aware of the space through which they move during practice or in real life situations...By 1956, a meeting of TC masters, convened by the Chinese National Athletic Committee, had produced a "combined" form of TC designed to convey the best components of the various TC schools, such as the Yang, Chen, Sun and Yin approaches that had evolved over the previous centuries (Mark, 1979). Despite this combined form, the individual approaches remain very distinct but continue to share in common the belief that TC arose from opposing forms of Yin (inactivity) and Yang (activity). Furthermore, all TC movements seek to balance Chi (vital energy) in the body's meridians and continued practice strengthens this vital energy, consequently reducing the potential for serious illness. The current practice of TC has evolved into relaxed, smooth, and graceful movements...Awareness of this sequencing originates through body loci at the waist and upper hips, with movement initiated in the half-squat position and progressing to the distal limbs. Against this historical perspective, a well-documented contemporary accounting of TC in numerous lay magazines attests to its almost ritualistic use by Chinese elderly...Many public forums promote the practice of the exercise form for people of all ages. When or how older individuals began using TC is uncertain. Most probably this occurrence was not sudden but rather a naturally occurring evolution as lifelong TC practitioners simply continued this activity while drawing notice because of their continued good health. Only recently has attention been given by Western science to the benefits of TC to the health of people living in Western cultures (*sic)* (p. 886).

Although Wolf et al.'s citation helps to better understand tai chi as a martial art, it fails to demonstrate the "attention" tai chi is receiving in Western society. Over the years, tai chi has been a growing form of exercise emerging from daily practice in China's public parks (Masley, 1998) to being practiced across the world (Adler & Roberts, 2006), especially among older adults (Wu, 2002). A parallel exists between the rise of tai chi practice and the vast body of tai chi literature and research. In a recent literature review of tai chi's breadth among research, Klein & Adams (2004) searched related articles and found a steady rise of 200 articles from the past two decades, with the highest number retrieved in 2002-2003. These articles, as well as other relevant research, have demonstrated various health benefits among older adults such as improved: quality of life, immune response, pain management (Klein & Adams, 2004), reduced fear of falls (Sattin et al., 2005), as well as components of physical function which include aerobic endurance, balance, flexibility and muscle strength (Klein & Adams, 2004).

Among the tai chi literature (refer to p. 33), tai chi exercise was demonstrated as beneficial to aspects of overall health and well-being (e.g. improved mood and reduced stress) of those that practice it; however, its influence on components of physical function and the relationship to falls among older adults is ambiguous. For example and to compare, recent literature reviews compiling evidence from 31 studies conclude future research is needed to demonstrate the effect of tai chi on fall prevention (Verhagen et al., 2004; Wu, 2002). Future research has been suggested because the literature reviewed showed both beneficial and non-beneficial effects of tai chi on targeted components of physical function (such as balance) and fall prevention. Similarly to these conclusions are the tai chi related scholarly articles retrieved for this literature review (n=6) which have demonstrated mixed outcomes of tai chi practice on targeted components of physical function. Among the studies that demonstrated benefits (Li et al., 2005; Lin et al., 2006; Suzuki et al., 2004; Voukelatos et al., 2007) by improving a component (e.g. balance) or multiple components (e.g. balance and aerobic endurance) of physical function, only two studies (Li et al., 2005; Suzuki et al., 2004) significantly reduced the risk of falls among older adults. For example, Lin et al. and Voukelatos et al. demonstrated an improvement in measures of balance but that did not lead to significantly reducing falls. In contrast, the remaining studies (Logghe et al., 2009; Woo et al., 2007) demonstrated no significant improvements in physical function components or in preventing falls. Based on these results, tai chi's influence on physical function while reducing the risk of falls remains unclear. This inconsistent finding has materialized into an essential gap that is recognized among not only tai chi studies but within all studies retrieved for this literature review. The gap that exists is the variation in types or styles of exercise used which is most prominent among tai chi literature. For demonstration purposes and due to the favourable results of tai chi, the variation in types of tai chi will be discussed but emphasize that variations of exercises existed across all studies.

2.3.3.1.1. Variation in types of tai chi exercise used

Tai chi has many styles which have been demonstrated among the literature. Among the studies retrieved, the types of tai chi practiced were Chen, Sun, and Yang style or a "mixture of several styles" (Voukelatos, 2007, p. 1186). Identifying each specific type of tai chi practiced among study participants is important as each type may have a direct influence on the study's results. For example, Logghe et al. and Woo et al. demonstrate no improvement of physical function components while significantly preventing falls when using Yang style, whereas Suzuki et al. and Li et al. demonstrate Yang style alone or in combination with Sun style respectively are effective. This inconsistency could be due to the (a) number of forms practiced and/or (b) focus and emphasis of each particular style. For example, Li et al. state Yang style uses 24 forms that emphasize multidirectional weight shifting, awareness of body alignment, and multi-segmental (arms, legs, and trunk) movement coordination; in comparison Lin et al. practiced Chen style which focuses on 13 forms but was not further defined. The concept of forms is understood as the performance of exercise movements. Aside from Voukelatos et al., the number of forms practiced was limited, and restricting movements (shortening exercises) may have a direct influence on improving physical function components and thus reducing physical risk factors of falls. Similarly, the undefined focus and emphasis of each particular style became increasingly apparent as majority of the studies did not clarify what their styles consisted of and/or emphasized. As a result of the lack of clarity and for better understanding, supplementary literature (Chen, Hsu, Chen, & Tseng, 2007; Chen & Synder, 1999; Wang, Collet, & Lau, 2004; Wu, 2002) was retrieved and summarized as follows:

- *Chen style* is the oldest form of tai chi that may vary from 35 to 100 forms or movements. It consists of quick, slow and large movements followed by vigorous ones. It primarily focuses on restrained and controlled actions.
- *Yang style* is the most popular form of tai chi that may vary from 10, 24, or 108 forms or movements. It consists of slow, large movements that are

graceful and evenly paced. It primarily focuses on wide stances and shifting of body weight.

- *Wu style* may vary from 35 to 108 forms or movements. It consists of compact and mid-paced movements with high and narrow stance width and a slower pace. It primarily focuses on footwork.
- *Sun style* may vary in number of forms (not consistently specified in literature) which are quick, compact and smooth, and primarily focuses on high stances that omit crouching techniques.

After supplementary research was sought out, complexities of understanding tai chi still remained and these general explanations do not justify the challenges of understanding the specific styles of tai chi. In spite of the challenges presented and based on these general explanations, an imperative question arises: how do these movements influence components of physical function (physical risk factors of falls) and therefore influence fall prevention? As demonstrated, the answer to this question has been vague among retrieved literature but, in contrast, it is clear that styles differ in focus and emphasis as well as in the number of forms or movements and/or intensity practiced. The evident disparity in style may have a direct influence on physical function and fall prevention. Therefore, the use of tai chi as a fall prevention exercise program may be over-generalized when, in theory, certain types of tai chi each having their own focus, emphasis and movements may be beneficial in improving physical function components while preventing falls.

The most predominantly practiced type of tai chi used among the retrieved literature was Yang style. Yang style has also been identified as the most popular style of tai chi (Wang et al., 2004). Although demonstrated to be popular and the most used as a fall prevention exercise program, the results of retrieved studies that used Yang style demonstrated mixed results. For example, Logghe et al. used 10 forms and Woo et al. used 24 forms but neither improved their targeted components of physical function which included balance, muscle strength and flexibility nor did it significantly prevent (reduce) falls. Alternatively, Li et al. used 24 forms and demonstrated improvements in flexibility, balance, coordination, speed/agility, and power which effectively reduced the number of falls. Li et al. became the only tai chi study to target more than three components of physical function and, as previously stated, the understanding and approach of including many components of physical function is imperative because it allows for a true portrayal of the effect of an exercise program on overall physical function, better demonstrating the comparative and influential relationship between physical risk factors and falls. The specific types of tai chi must be considered to discover the optimal style and, furthermore, to recommend and justify it as an effective *fall prevention* exercise program.

2.4. Summary

By reviewing and analyzing literature to answer research questions previously established (refer to p. 11), it demonstrated mixed evidence regarding whether community-based group exercise programs are beneficial in improving components of physical function while preventing falls due to the various aforementioned concerns. Although the types of exercises practiced varied across all studies, tai chi and, more specifically, Yang style tai chi emerged as the most frequently practiced fall prevention exercise program used in research. Similarly, tai chi practice for improving physical function and preventing falls is ambiguous. This may be a result of the various styles or characteristics practiced and the influence of targeted components of physical function. The tai chi literature did not target all identified physical function components and, as a result, did not demonstrate a thorough understanding of its influence on overall physical function through its components (i.e. physical risk factors of falls). The inclusion of all physical function components aids in understanding what effect tai chi may have on other components of physical function and whether they are influential in fall prevention. If fall prevention is essential to an exercise program, then the most optimal approach would be to improve identified physical function components as they have been understood as physical risk factors that are key predictors of falls. This will further demonstrate the effectiveness of tai chi as a fall prevention exercise program. Therefore, the updated research question (from p. 12) is as follows:

- Is Yang style tai chi a "one size fits all" fall prevention exercise program for older adults for improving all identified components of physical function which accordingly reduces the physical risk factors of falls?

While determining the answer to this question, the proposed study will address and evaluate the aforementioned concerns which include:

- clearly stating and defining a *fall* among stakeholders
- capturing non-injurious and near falls

- use of reporting systems that ensure confidentiality and consider autonomy
- decrease duration of the exercise program to reduce dropout rates and increase compliance
- specify what type of tai chi will be used to and determine effectiveness as a fall prevention exercise program
- ensure no limitations or restriction of tai chi movement is in place
- investigate whether Yang style tai chi exercise participation improves components of physical function (through a comprehensive process) which in turn prevents falls and fall-related injuries by reducing the associated physical risk of falls

To summarize, the conceptual aim of this study is to report the relationship between factors that influence Yang style tai chi on the multi variable components of physical function and its relationship to fall prevention among independently living older adults. It is anticipated that this approach will aid in determining which types of exercise interventions are most effective for reducing fall risk and, furthermore, it will aid in determining the profile of an optimal fall prevention exercise program. This study will address the aforementioned concerns while providing innovative and novel Canadian research as it is the first in Canada investigating Yang style tai chi and its influence on components of physical function and fall prevention among community-dwelling older adults aged 60 and above. This will also be the first study to use a Community Based Research (CBR) approach to guide to research (to be discussed further in Chapter 3).

CHAPTER 3

METHODOLOGY

This chapter describes the research methodology and procedures used for the study. It is important to note that this chapter does not illustrate the results of the methodological approach. Rather, it maps the process strategically designed and implemented to meet the study's aim. It consists of the following sections and is organized in sequence:

1. *Hypothesis and study design*: explains the approach used to meet the study's aim.
2. *Study participants*: identifies descriptive details of the sample population.
3. *Setting and profile*: explains where the participants were recruited from.
4. *Study orientation*: explains the orientation used to guide the study.
5. *Ethics and research approval:* explains steps to protect and conduct research with human subjects.
6. *Recruitment strategy*: demonstrates how the participants were recruited.
7. *Assessment procedure*: demonstrates steps leading to the measures.
8. *Measuring outcomes*: explains details of how outcomes were measured.
9. *Intervention*: explains details about Yang style tai chi exercise.
10. *Managing risk and dropout*: explains how identified risks and dropouts were managed.
11. *Statistical analysis*: explains how the variables were examined.

3.1. Hypothesis and study design

For the purpose of investigating the effect of Yang style tai chi (as a fall prevention exercise program) on components of physical function (physical fall risk factors) among older adults, a two-fold hypothesis has been established:

Hypothesis A involves a Yang style tai chi exercise program practiced by older adults aged 60 years and above. It is anticipated that:

(a) this therapeutic intervention will improve components of physical function which consists of body composition, muscle strength, muscle endurance, aerobic endurance, flexibility, and generalised motor abilities involving balance, coordination, speed/agility and power.

(b) improvements to these components of physical function will support the general purpose of Hypothesis B and will demonstrate a reduction in the relative physical risk of falling.

In order to test the hypothesis, a quantitative one group pretest-posttest (before-after) experimental design with prospective measures was conducted[3].

3.2. Study participants

In order to control for internal variance, the effect of antecedent variables[4] were controlled. Study participants having a minimum risk of falls status were accepted for inclusion in the study because those with high risk (or fall prone) would compromise the relationships of the independent variable and possibly confound/distort the results of the

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[3] A before-after experimental prospective design generates considerable confidence that change as a result of exposure to the independent variable (Yang style tai chi exercise) may be precisely measured, strengthening its internal validity (Polit & Beck, 2008).

[4] LoBiondo-Wood & Haber (2005) define antecedent variables as, “variables that affect the dependent variable but occurs before the introduction of the independent variable.” (p. 509)

study. Study participants were therefore community-dwelling older adults that met specific inclusion/exclusion criteria. The inclusion criteria consisted of the following:

- Both male and female aged 60 years and above.
- Independently living[5].
- Considered to be healthy[6].

Exclusion criteria consisted of the following:

- Suffer from degenerative neurological conditions that impair equilibrium: vertigo[7] and Parkinson's disease[8].
- Are under heavy medications (more than three) from a drug class known as benzodiazepines[9].

3.3. Setting and profile

Study participants were recruited from the Village of Taunton Mills community health centre located in Whitby, Ontario. The Village of Taunton Mills[10] is one of eleven

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[5] For the purpose of this study independently living is understood as a living arrangement where there is limited or no assistance with ADL. It was also further understood that older adults who were dependent on wheelchairs needed added assistance with ADL and therefore only those with or without walking aids were included.

[6] For the purpose of this study healthy is understood as having the ability to cope with disabling conditions.

[7] *Vertigo* is a sensation of motion where the individual's surroundings seem to rotate causing a state of dizziness (Merriam-Webster's Dictionary, 2010) and this state is a risk factor for the onset of falls (Friedman, Munoz, West, Rubin, & Fried, 2002).

[8] *Parkinson's disease* is characterized by tremor, rigidity, bradykinesia (slowed movements), gait disturbances, and postural instability which are typical signs of increased risk of falling (Gray & Hildebrand, 2000).

[9] Benzodiazepines are frequently used drugs prescribed for sleep disorders among the older adult population (Pariente, Dartigues, Benichou, Letenneur, & Fourrier-Reglat, 2008) and have been demonstrated to be significantly associated with the occurrence of injurious falls (Koski, Luukinen, Laippala, & Kivela, 1996; Pariente et al., 2008; Tinetti, Speechley, & Ginter, 1988).

continuums of care facilities in Ontario combined that offer a range of healthcare options for those independently (retirement) and non-independently (long-term care) living. They are owned by a private Canadian corporation called Schlegal Villages and are managed by RBJ Schlegal Holdings. RBJ Schlegal Holdings is partnered with the Research Institute of Aging (RIA). RIA promotes and supports research that is relevant to aging and quality of life in community settings for sustainable and beneficial programming among older adults (RIA, 2011).

3.4. Study orientation

As a result of the study taking a community perspective with multiple stakeholders that include RIA, University of Ontario Institute of Technology (UOIT), and the Village of Taunton Mills, it was important to have a strategic orientation to guide the research study. Therefore this study used an adaptation of a Community-Based Research (CBR) approach. Green et al. (1995) define CBR as a "systematic investigation with the participation of those affected by an issue or purposes of education and action or affecting social change" (p. 3). Minkler (2005) describes CBR's strength as involving integrating academic and community education/knowledge through *social action*. For the purpose of this research, social action is defined as when individuals interact with society to achieve a specific identified goal. In this study, the CBR paradigm was applied to enhance health of older adults and, more specifically, to increase physical function in order to reduce the risk of falls (prevent falls) amongst older adults. Minkler further states that "CBR is not a method per se but an orientation to research that may employ any of qualitative and quantitative methodologies" (p. 5). When initial contact with RIA and the

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[10] The Village of Taunton Mills was established in 2003 and currently has the capacity for approximately 300 older adults (residents), 180 in retirement and 120 in long-term care.

Village of Taunton Mills was made, there was a mutual understanding that a lack of exercise participation affects a large number of residents in the Village of Taunton Mills. Consequently the use of tai chi was jointly approved by all stakeholders. Justification for the receipt of mutual approval among all stakeholders is influenced by the core principles of CBR: (a) developing a mutual benefit for all partners, (b) increase capacity building, (c) establishing a co-learning environment, and (d) reduce disparities by committing long-term (Wallerstein & Duran, 2006). These four principles provided the study with an abstract structure. As a result, every effort was made to sustain these principles through the duration of the study. CBR principles are therefore emphasized throughout the remaining methodological sections and the influence of its use generated recommendations for community health practice (to be discussed in Chapter 5).

3.5. Ethics and research approval

Before commencement of the study occurred with human subjects, ethics and research approval was granted from identified stakeholders: UOIT, RIA and the Village of Taunton Mills, with guidance from a representative of each stakeholder: specifically RIA's Research Coordinator, UOIT's Investigator and Supervisor, and the Village of Taunton Mills' Director of Recreation and two Kinesiologists. The process of obtaining approval among these stakeholders was followed:

1. An ethics application form was provided by and submitted to UOIT's Research Ethics Board (REB).
2. After receiving approval by UOIT's REB (certificate #10-008), a research proposal which summarized the state of the problem, the study's purpose and

methods to be used was submitted to a Research Coordinator from RIA and to the Director of the Village of Taunton Mills for joint review and approval.

3. Following the acceptance of the research proposal (see Appendix F), a partnership was established with RIA and the Village of Taunton Mills. This partnership allowed for access to residents at the Village of Taunton Mills and the use of their facility as a single host site for the study.

Additionally, all data collected and recorded (both hardcopies and softcopies) was stored (upon study completion) in a combination-secured metal cabinet located in the Supervisors UOIT's office for five years and thereafter will be destroyed.

3.6. Recruitment strategy

After obtaining approval and thereby establishing a partnership with RIA and Taunton Mills, a recruitment strategy was implemented as follows:

1. *Commencement meeting*. A meeting was conducted between representatives from RIA (Research Coordinator, the primary recruiting lead), the research team (Investigator and Supervisor), and the Village of Taunton Mills (Director of Recreation and two Kinesiologists). The purpose of the meeting was to introduce the research and mutually approve future directions.
2. *Eligibility list*. Subsequent to the commencement meeting, the creation of an eligibility list was initiated by the Research Coordinator and Kinesiologists who had health-related knowledge of the residents. The finalized eligibility list consisted of potential participants that were screened based on the study's inclusion and exclusion criteria provided by the Investigator (refer to section 3.2.).

3. *Information package.* An *information package* consisting of three parts: (a) cover letter, (b) information letter and (c) interest forms were mailed to each resident on the eligibility list (see Appendix G). If no response or feedback was obtained within two weeks of distributing the information package, the Research Coordinator conducted a follow-up by face-to-face meetings (going to the resident's room) or by telephone. Note: follow-up and contact throughout the study was completed using this same process.
4. *Presentation.* After a list of eligible participants received the information packages, a presentation was made to residents of the Village of Taunton Mills to help better understand physical function, falls, and benefits of exercise. More importantly, the presentation was an opportunity to enhance recruitment while explaining the study's aim, methodology, risks and benefits of participation, and further explain the *information packages*. A poster was placed on announcement boards within the facility to generate interest and encourage older adults to attend (see Appendix H). During the presentation, an *interest letter* package was handed out to each attendee (see Appendix I). The *interest letter* package was similar to interest forms as seen in the *information package*. The reason for handing out two interest documents was to increase awareness and improve chances of recruitment. Note: the *interest letter* and *information package* were preliminary and some information was subject to change.
5. *Distribution and collections of interest forms*. Older adults who were interested in participating were asked to fill out the interest form located

within *the information package* or *interest letter*. After completing the interest form they were asked to place it in the provided envelope and submit it to appropriate persons (as described in the presentation) or drop it off to the Receptionist located in the main office. After the presentation and roughly two weeks after mailing the *information package* to eligible participants, interest forms were collected by the Research Coordinator.

6. *Establishing a willing participant list*. After the interest forms were collected, the Research Coordinator contacted all the potential participants to confirm interest in the study. Those that did not fill out the interest form but were on the eligibility list were contacted to determine their interest. Those that did fill out the interest form but were ineligible to participate were informed of other exercise classes that they could attend within the facility. After all interested and eligible participants were confirmed, the Research Coordinator developed a *list of willing participants*.

The target of the recruitment strategy was to enrol as many participants that met inclusion and exclusion criteria. Rather than using power analysis to predetermine a sample size, this approach was preferred to establish the level of interest among older adults for tai chi exercise as a public health intervention. To clarify, instead of predetermining a specific sample size needed for power or effect and therefore using incentives to participate in the study, the study was promoted as a public health intervention without incentives as it would normally be conducted within communities. This will allow for an understanding of interest in tai chi exercise among the community and aid in determining approval for future use.

3.7. Assessment procedure

After first obtaining ethics and research approval and thereafter completing the recruitment strategy presented above, an assessment procedure was implemented as follows:

1. *Develop a coded participant list.* The Research Coordinator randomly assigned a reference identification code to each willing participant. In order to assign a code to each participant, the Investigator provided a coded participant template (see Table 4 in Appendix J, note first column). The randomized coding method, a three-digit number followed by a letter (e.g. 987H) was used to ensure privacy and confidentiality throughout the study (especially from documented results of performance assessments) as stakeholders (UOIT, RIA and the Village of Taunton Mills) would only have knowledge of assigned codes. This ensures the elimination of (a) participant and investigator's bias as related to performing, and (b) stakeholders being able to identify participants (detection). The *coded participant list* served two purposes: (a) the Research Coordinator used it as a master identification sheet, and (b) the Investigator used the assigned code to organize, collect and record information based on two packages made for each participant (described below). All documents within the package had the matching assigned code.
2. *Package #1: Screening forms*. After the assigned codes were received by email (no names or contact information were sent) from the Research Coordinator, the Investigator developed Package #1. Package #1 was influenced by screening steps outlined by Jones & Rose's (2005) "*Physical*

activity instructions for Older Adults". It served as an endorsement to participate in the study and consisted of the following documents: (a) participant consent form, which was collected as per Tri-Council Policy Standards in Canada (TCPS) (Canadian Institute of Health Research et al., 2005) prior to the commencement of the study (see Appendix K), (b) Physical Activity Readiness Questionnaire (PAR-Q) (see Appendix L), revised by Thomas, Reading, & Shephard (1992) to determine a participant's readiness to take part in an exercise program (for those below 69 years old) without physician's consent, and (c) medical clearance form (see Appendix M). Also included in this package: (d) access to falls registry and (e) access to medication history. These documents will be further described in section 3.7.1. Package #1 was given to the Research Coordinator for use during the first of two important meetings with willing participants.

3. *Package #2: Assessment forms*. Subsequent to the completion of Package #1, Package #2 was created and consisted of (a) demographic data sheet and (b) assessment result sheets both used for recording baseline characters (i.e. gender, height, weight, and use of a walking aid) and primary outcome measures respectively. As a result of its use, it was kept with the Investigator for assessment purposes. These documents will be discussed in detail in section 3.7.2.
4. *Set up assessment schedule.* The Research Coordinator organized two meetings using the coded participant list. See Appendix N for an example of

the assessment schedule template used to book meetings and also to allow the Investigator to know dates/times of assessments.

5. *Meeting #1: pre-assessment day one*. The first meeting consisted of two parts. First, the Research Coordinator reviewed *Package #1: Screening forms* while giving the participants an opportunity to endorse participation (an on-site medical practitioner was available to give consent for medical clearance). Second, after receiving consent, the participants were asked if they would like to complete *pre-assessment day one* (assessed by outcome measures to be described). If the participants agreed to complete *pre-assessment day one* they were asked to meet the Investigator (a Certified Kinesiologist with credentials to conduct assessments) in another room, bringing Package #1 with them. The Investigator would then verify their assigned codes and complete *pre-assessment day one* with use of assessment forms within Package #2. If the participant did not have consent or did not want to complete *pre-assessment day one,* they were rescheduled by the Research Coordinator.
6. *Meeting#2: pre-assessment day two*. *Pre-assessment day two* (assessed by the remaining outcome measures) was completed. At the end of meeting #2, participants were introduced to the primary outcome measure of the study.

3.8. Measuring outcomes

Outcome measures consisted of two parts (primary and secondary) dictated by the study's hypothesis and aim. The two outcome measures are as follows:

3.8.1. Primary outcome measures

Primary outcome measures were used to measure physical function consisting of its components and fall risk. Each component was measured by applying and supplementing Rikli & Jones (2001) "*Senior Fit Test"* (SFT). The SFT was created based on test selection criteria from Rikli & Jones's (1999a) two-year national research project which analysed the reliability and validity of measurements (tests) used for physical function among 7,183 independent-living male and female older adults, ages 60 to 90+, across a wide range of ability levels from borderline frail to high physical function ability. The purpose and test selection process of Rikli & Jones's (1999a) two-year research project was to develop and validate a battery of performance tests suitable for assessing the major underlying physical parameters associated with physical function in independent older adults. The test items selected were based on the assessment test's influence on physical function and incorporated both upper and lower body measures. For the purpose of this study, five tests that focused on lower body were used. In addition, the Berg Balance Scale (BBS) was incorporated as there was a lack of specifically testing for static balance among Rikli & Jones's SFT. Thus, testing for this study included six outcome measures that were identically conducted at baseline (two weeks prior to start date) and post intervention (two weeks following end date) by a Certified Kinesiologist (Investigator).

3.8.1.1. Measuring physical function

During the first pre-test and post-test assessment meetings (day one), participants completed measures for body composition and balance.

3.8.1.1.1. Body mass index - Body composition

Using the demographic data sheet as presented in Package #2 (see Appendix O); components of body composition such as height and weight were recorded. Height and weight were measured according to standard anthropometric procedures (Lohman, Roche, & Martorell, 1991) to describe physical characteristics. The participant's height and weight were used to calculate Body Mass Index (BMI)[11]. BMI scores are determined by dividing weight in kilograms by height in meters squared (BMI = kg/m^2) and results are compared to a BMI conversion chart (see Table 5 in Appendix P) (Rikli & Jones, 2001).

3.8.1.1.2. Berg balance scale - Static and dynamic balance

BBS is a 14-item scale developed as a functional measure of static balance as well as dynamic balance in older adults by assessing the performance of ADL related tasks (e.g. picking up an object off the floor) (Berg et al., 1989; Berg et al., 1992). Participants were asked to maintain stability during the activity and if the time or distance requirements were not met or if the participant received assistance from the Investigator points were deducted. Each item or task is related to performance which is scored on an ordinal scale from 0 (unable to perform the task) to 4 (able to perform the task independently), with a total possible score of 56 (Berg et al., 1992). Total scores are then compared to predetermine score ranges that categorize each participant in a particular fall/physical function risk zone (i.e. low, medium, and high) (Berg et al., 1992).
In order to determine fall risk, the scores are then compared to a predetermined range where scores from 0-20 indicates a high fall risk, 21-40 indicates a medium fall risk, 41-56 indicates a low fall risk (refer to Appendix Q for details of each test item and how each test is scored in relation to fall risk).

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[11] BMI is a method of determining the appropriateness of a participant's body weight in relation to their height and is a common measure for body composition (Rikli & Jones, 2001).

BBS has been proven to be a reliable and valid form of measuring balance (Berg, Wood-Dauphinee, & Willams, 1995). Specifically, BBS has been shown to have excellent inter-rater reliability (.98), and high construct validity (Cronbach`s α of .96) (Berg et al., 1989; Liston & Brouwer, 1996). A further validation study by Berg et al., (1992) illustrated the BBS scores showed high concurrent validity with other measures of balance: Tinetti's mobility index[12] (r =.91) (Tinetti, Williams, & Mayewski, 1986) and the 8 foot Timed Up-and-Go test [TUG] (r =-.76) (Podsiadlo & Richardson, 1991). Also a recent study (Sahin et al., 2008) determined the Intraclass Correlation Coefficient (ICC) used to evaluate test-retest reliability of BBS measuring balance was .98 (an ICC above .80 is an indicator of high reliability). In addition, the BBS has been demonstrated to measure physical function as it is necessary in the performance of ADL (Berg et al., 1989; Berg et al., 1992).

During the second pre-test and post-test assessment meetings (day two), participants completed the SFT which measures muscle strength and endurance, flexibility, mobility and aerobic endurance. Prior to providing a description of each test used to measure these components, it is essential to describe how Rikli & Jones established reliability and validity. In regards to reliability, Rikli & Jones (1999a) conducted a study among 82 independently living older adults. All tests (30-second chair stand, chair sit-and-reach, 8-foot timed up and go, 6-minute walk) were administered and retested two to five days later. A one-way ANOVA was used to provide information on the amount of change in scores from test to retest days, if any. Intraclass reliability values (*r)* demonstrated 30-second chair stand (*r* =.89), chair sit-and-reach (*r* =.95), 8-foot timed

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[12] Tinetti, Williams, & Mayewski (1986) describe the Tinetti's mobility index as an integrated assessment of mobility and balance among older adults, and is the best single predictor of recurrent falls.

up and go (r =.95), and 6-minute walk (r =.94) that have good reliability across all trials (Rikli & Jones, 1999a).

In regards to validity, there are three types: (a) *content validity*, which is understood as the degree to which a test reflects a defined universe of domain (Bowling & Ebrahim, 2005), (b) *construct validity*, which represents the degree to which a test measures a particular attribute that exists in theory but cannot be directly measured (Bowling & Ebrahim, 2005) (i.e. physical function) and (c) *criterion validity*, which represents the degree to which a test correlates with a criterion measure that is already known to be valid and is measured by calculating the correlation coefficient (Pearson's r) (Bowling & Ebrahim, 2005). First, content validity in this context would be whether a test measures the component of physical function (i.e. does chair sit-and-reach measure flexibility?). In order to demonstrate content validity, Rikli & Jones (1999a; 2001) used a scientific advisory panel for subjective judgement on each test. This understanding was supported by the American Psychological Association's (APA) standards which state content validity can come from subjective judgement of experts in the field (Rikli & Jones, 2001). Second as far as construct validity, Rikli & Jones (1999a; 2001) conducted a study which consisted of 190 older adults who were separated by level of activity (regular exercisers versus non-exercisers). To assess the construct validity of the SFT tests, comparisons were made between older adults who were regular exercisers and those who were not regularly active, with the assumption that exercisers would possess higher levels of physical function than non-exercisers. Scores on each test were analyzed to "determine the test's ability to detect expected performance differences (declines) over three decades – the 60s, 70s, and 80s – as well as expected differences in people with high and low levels of physical activity" (Rikli & Jones, 2001, p. 28). The results for content validity as well as the third validity measure - criterion validity will be discussed within each test's description which is as follows:

3.8.1.1.3. 30-second chair stand - Muscle strength and muscle endurance

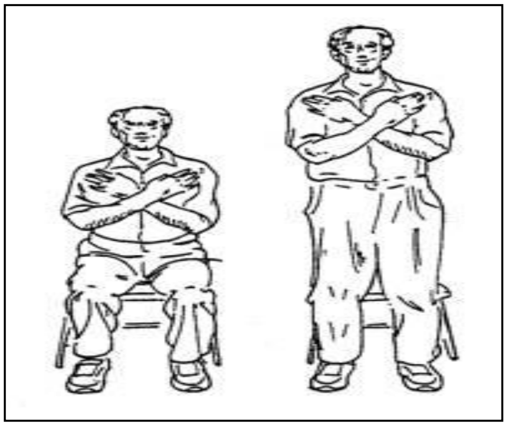

Figure 6. An illustration to demonstrate the 30-Second Chair Stand (30-SCS) test. Adapted from "*Senior fitness test manual"* by C.J. Jones & R. E. Rikli, 2001, p.61. Copyright 2001 by Human Kinetics.

The 30-Second Chair Stand (30-SCS) is a test used to assess overall lower body muscle strength and endurance. It involves counting the number of times within a 30-second time period that a person can come to a full stand from a seated position with arms folded across their chest (see Figure 6). A higher number of repetitions results in a better score.

To test criterion validity of the 30-SCS test, Rikli & Jones used 30-SCS scores and compared it to leg press strength (considered as the gold standard) as measured by a Keiser double leg press machine (Jones et al., 1999; Rikli & Jones, 1999a). The Keiser double leg press machine is a multiple joint exercise involving hip extension, knee extension, and ankle plantar flexion in order to measure lower body muscle strength (Jones et al., 1999; Rikli & Jones, 1999a). Rikli and Jones (2001) states, "Leg press was measured using 1-RM (repetition maximum) protocol that had previously been determined to have high test-retest reliability in older adults (Rikli, Jones, Beam, Duncun, & Lamar, 1996)" (p. 29). Specifically, Jones et al.'s (1999) study among 67 older adults who performed two 30-SCS tests and two maximum leg-press tests conducted two days apart demonstrated the following:

> Test-retest intraclass correlations of .84 for men and .92 for women, utilizing one-way analysis of variance procedures appropriate for a single trial, together with a non-significant change in scores from Day 1 testing to Day 2, indicate that the 30-s chair stand has good stability reliability. A moderately high correlation between chair-stand performance and maximum weight-adjusted leg-press performance for both men and women (*r* =.78 and .71, respectively) supports the criterion-related validity of the chair stand as a measure of lower body strength. Construct (or discriminant) validity of the chair stand was demonstrated by the test's ability to detect differences between various age and physical activity level groups. As expected, chair-stand performance decreased significantly across age groups in decades--from the 60s to the 70s to the 80s ($p < .01$) and was significantly lower for low-active participants than for high-active participants ($p < .0001$). It was concluded that the 30-s chair stand provides a reasonably reliable and valid indicator of lower body strength in generally active, community-dwelling older adults (p. 113).

Results of Jones et al.’s study supports the good test-retest reliability of the 30-SCS and provides a valid indication of lower body muscle strength. In addition, although Rikli & Jones (2001) state 30-SCS is a good indicator of lower body muscle endurance, it lacked supporting evidence as it demonstrated for lower body muscle strength. As a result, supporting literature was sought out to support 30-SCS as a good indicator of lower body muscle endurance. This search posed a challenge as merely one source

(Howley & Franks, 2007) showed the 30-SCS to be a good indicator of lower body muscle endurance. However, the definition of muscle endurance presented in Table 2 (Appendix C) demonstrates that muscle endurance is the ability of a muscle group to exert external force, which is based on successive repetitions. With this understanding, muscle endurance can be measured by the number of chair stands (repetitions) completed within 30 seconds, and the result (score) can be compared to before and after the intervention to investigate observable change, if any.

In support of construct validity, the results of Rikli & Jones' (1999a; 2001) study showed scores from 30-SCS test discriminated significantly between exercisers and non-exercisers where exercisers completed an average of 13.3 stands and non-exercisers completed an average of 10.8 stands. Furthermore, declines in lower body muscle strength and endurance have been associated with decreased ability to maintain postural stability (Bohannon, 1995) and a contributor to an increased risk of falling (Ballard et al.. 2004; Freiberger et al., 2007; PHAC, 2005; Rikli & Jones, 1999a; Shumway-Cook et al., 2007; Tinetti et al., 1988). MacRae, Lacourse, & Moldavon (1992) have also suggested the 30-second chair stand test is effective in discriminating between fallers and non-fallers.

3.8.1.1.4. Chair sit-and-reach - Flexibility

The Chair Sit-and-Reach (CSR) test is used to assess overall lower body flexibility, in particular hamstring flexibility. The test begins with the participant sitting on the edge of a chair. They are asked to extend one leg straight out in front of their hip with their foot flexed leaving their heel resting on the ground. They are then asked to reach forward with their arms outstretched and overlapping, and middle fingers even,

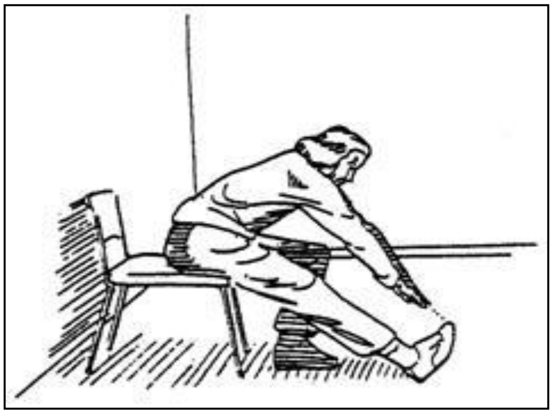

Figure 7. An illustration to demonstrate the Chair Sit-and-Reach (CSR) test. Adapted from "Senior fitness test manual" by C.J. Jones & R. E. Rikli, 2001, p.69. Copyright 2001 by Human Kinetics.

reaching as far forward as possible toward or past the toes of the straightened leg (see Figure 7). Their score in inches is measured by the distance (+ or -) from the top of their toe being the point of zero. The more positive the score is, the better the results.

In order to assess criterion validity of the CSR test, "scores were compared to a common 'gold standard' criterion – that of goniometer-measured hamstring flexibility (American Academy of Orthopaedic Surgeons, 1966), the correlation between chair sit-and-reach stands and the goniometer – measured criterion was .83 (n=80)" (Rikli & Jones, 1999a, p. 145) demonstrating CSR to be a valid test of flexibility. Furthermore, "Past studies indicate that sit-and-reach tests, in general, have at least moderate criterion-related validity relative to established measures of hamstring flexibility, with *r* values ranging from .61 to .89 (Jackson & Baker, 1986; Jackson & Langford, 1989; Patterson, Wiksten, Ray, Flanders, & Sanphy, 1996)" (Rikli & Jones, 2001, p. 36).

In support of construct validity, the results of Rikli & Jones' (1999a; 2001) studies showed scores from CSR test discriminated significantly between exerciser and non-exercisers where exercisers had an average of -0.6 inches and non-exercisers had an average of -3.8 inches. In relationship to fall prevention, insufficient range of motion or lack of flexibility of the lower body is associated with increased risk of falling in older adults (Freiberger et al., 2007; Iwamoto et al., 2009; Means et al., 2005; PHAC, 2005; Rikli & Jones, 1999a; Skelton et al., 2005; Suzuki et al., 2004; Woo et al., 2007).

3.8.1.1.5. 8-foot timed up-and-go test - Mobility (dynamic balance, coordination, speed/agility, and power)

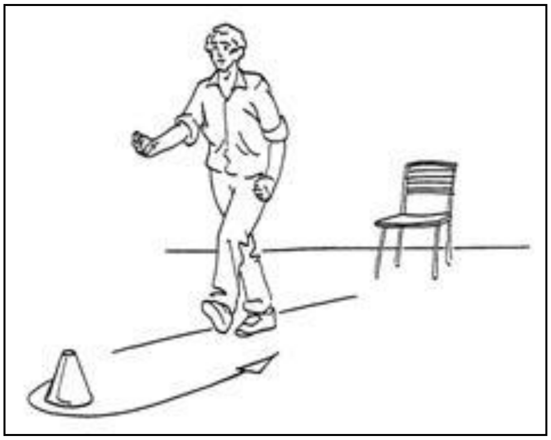

Figure 8. An illustration to demonstrate the 8-foot Timed Up-and-Go (TUG) test. Adapted from "*Senior fitness test manual"* by C.J. Jones & R. E. Rikli, 2001, p.72. Copyright 2001 by Human Kinetics.

The 8-foot Timed Up-and-Go (TUG) test is used to measure mobility which includes dynamic balance, coordination, speed/agility, and power. Podsiadlo & Richardson (1991) further illustrate that TUG is a test of dynamic balance that is commonly used to examine functional mobility in community-dwelling older adults. The test requires the participant to sit in the middle of the chair with back straight, feet flat on the floor and hands on their thighs. On the signal "go", the participant gets up from the chair; walk as quickly as possible around either side of an object located 8 feet away from the centre of the chair, and sits back down in the chair (see Figure 8). A stopwatch is used to record the time (in seconds) taken to stand, walk around the object and to sit back down. The time taken to complete the test is strongly correlated to level of functional mobility (Podsiadlo & Richardson, 1991; Rikli & Jones, 1999a).

In order to assess criterion validity of the TUG test, Rikli & Jones (1999a) state, "Although there is no one gold standard criterion measure to compare performance on the TUG, it has been found to be significantly related to items in the BBS (r =.81), to gait speed (r =.61), and to the Barthel Index of ADLs (r =.78)" (p. 147). Also, "…8-ft up-and-go performance is an excellent discriminator among various age groups, with performance declining significantly from the 60s to the 70s to the 80s" (Rikli & Jones, 1999a, p. 147).

In support of construct validity, the results of Rikli & Jones (1999a; 2001) studies showed scores from TUG test discriminated significantly between exerciser and non-exercisers where exercisers had an average of 6.0 seconds and non-exercisers had an average of 7.2 seconds (Rikli & Jones, 1999a). In relationship to fall prevention, a lack of mobility increases the likelihood of falls and recurrent falls and is shown to be a contributor to increasing fall risk (Ballard et al., 2004; Freiberger et al., 2007; Iwamoto et al., 2009; Means et al., 2005; PHAC, 2005; Shumway-Cook, Brauer, & Woollacott, 2000; Shumway-Cook et al., 2007).

3.8.1.1.6. 6-minute walk – Aerobic endurance

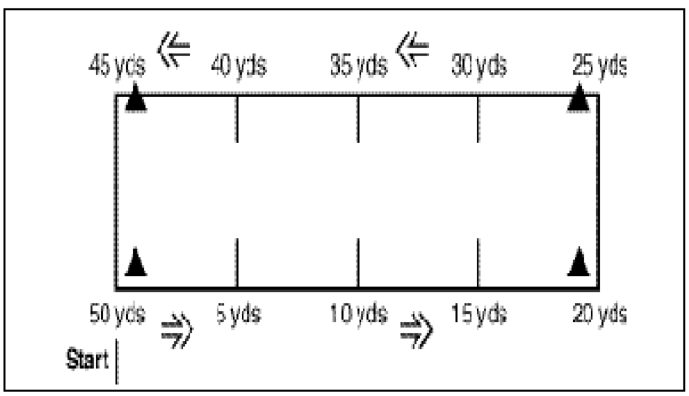

Figure 9. An illustration to demonstrate the 6-minute walk (6MW) test. Adapted from "*Senior fitness test manual"* by C.J. Jones & R. E. Rikli, 2001, p.65. Copyright 2001 by Human Kinetics.

The 6-Minute Walk (6MW) test is used to measure aerobic endurance. It involves the number of yards/meters that can be walked in 6 minutes around a 50-yard (45.7 meter) course (see Figure 9). The rationale for standardizing time instead of a set distance was to improve the scoring effectiveness of the test and would aid in determining physical function levels (ability) of exercisers versus non-exercisers (Rikli & Jones, 1999a). Although studies have demonstrated high correlations between 6MW and aerobic endurance (Steffen, Hacker, & Mollinger, 2002; Haykowsky et al., 2005), the

6MW test had not been validated on healthy independent-living older adults. As a result, Rikli & Jones (1999a) designed a study which is summarized as follows:

> To further test the criterion validity of the 6-minute walk as a measure of aerobic (cardiovascular) endurance, we designed a study that compared the 6-minute walk test scores of 77 independent-living older men and women (mean age =73 years) with sub maximal treadmill walking performance using modified, previously validated Balke protocol (American College of Sport Medicine, 1991). Scores collected during the Balke graded exercise test represented total time on the treadmill before reaching 85% of predicted maximum heart rate. Results revealed an overall correlation of .78 between 6-minute walk test scores and scores on the treadmill test, indicating moderately good criterion-related validity (Rikli & Jones, 1998)…Submaximal physical performance (as opposed to a measure of maximal oxygen consumption) was selected as the criterion measure to study because of its greater relevance to older adult functioning.

Results demonstrate fairly high criterion validity to a valid test of Balke protocol. The Balke protocol is a test developed to determine the peak maximum oxygen uptake (*VO2* max[13]) in active and sedentary men and women (Pollock et al., 1976). *VO2* max is important because, theoretically, the more oxygen one can use during activity, the more energy one can produce, aiding in better results. An adequate level of aerobic endurance

[13] *VO2* max is understood as the maximum oxygen uptake an individual can utilize during maximal exercise and as a result is an indicator of maintaining maximum duration for specific activity (aerobic endurance).

during aging is necessary to perform many ADL because lack of energy is directly related to a person's functional mobility (Rikli & Jones, 2001).

3.8.1.2. Measuring fall risk

After results of the six outcome measures determined physical function (see Table 6 in Appendix R for a description summary of each outcome measure and its targeted component of physical function), the results were compared to performance standards in order to determine a level of physical function and its relationship to fall risk. Among the six measures and as previously mentioned within each section, BMI and BBS have their own performance standards. To review, the remaining outcome measures (30-SCS, CSR, TUG, 6MW) were part of the SFT. A valuable characteristic of the SFT is the ability to match and compare results (scores) of each assessment to performance standards for older adults. Performance standards consist of two parts: norm-referenced scores and criterion referenced scores. Both normative and criterion-referenced standards were developed for the SFT based on the previously mentioned national study conducted by Rikli & Jones. Specifically, normative scores were established within Rikli & Jones' study (1999a, 1999b) which compared SFT results of older adult participants (n=7183) by categorizing SFT scores into percentiles (i.e. 25th, 50th, and 75th percentile) and further categorized by gender and age. The 50th percentile was considered "normal" and higher scores were categorized as "above average" and lower scores were categorized as "below average". See Appendix S for normative scores for women and men (Table 7a and Table 7b respectively).

Alternatively, criterion-referenced standards were developed to understand physical function levels needed to maintain functional independence and avoid at-risk zones. At-risk zones were established within Rikli & Jones' national study through self-evaluation using a Composite 12-item Physical Functional (CPF) scale. The CPF was designed to assess physical function across a wide range of abilities from basic ADL to advanced ADL. Rikli & Jones used the CPF within the national study to calculate CPF scores. "CPF scores were used to categorize individuals as having either high physical function or low physical function, with high functioning being those who indicated that they could perform all 12 items with no difficulty and low functioning being those who could perform no more than 50% (6 or fewer) of the task without difficulty" (Rikli & Jones, 2001, p. 49). The CPF scores were then compared to the SFT scores which revealed a strong positive association between physical function level (performance-based measure) and self-reported physical function ability level, with higher physical function scores being associated with high self-reported physical function ability and low physical function scores being associated with low self-reported physical function ability. Rikli & Jones further state that, the average physical function scores of those who reported having difficulties with ADL associated with independently living provide a type of threshold value or criterion reference point that is associated with "loss of physical function". To clarify, those that had low scores on their performance-based measures as related to the SFT demonstrated low CPF scores. As a result, the average of SFT scores (i.e. the average scores of 30-SCS, CSR, TUG, 6MW) of those who had low CPF scores identifying them as older adults with low physical function (or below average) were taken and used as at-risk zone boundaries. Accordingly, CPF scores developed four categories/levels of physical function in descending order which are: (1) above average, (2) normal range, (3) below average, and (4) loss of physical function (at-risk boundaries). Rikli & Jones (1999a; 2001) state the levels of physical function provide an indication of the level of fall risk where test result that are under "below average" puts you at a "loss of physical function" and therefore at the highest risk of falling. This was determined as majority of participants within Rikli & Jones' national study that were in at-risk zones were fallers. Therefore, the purpose of the criterion-referenced standards is to identify where an older adult would fall in respect to the at-risk zone of the specified component of physical function. To further clarify, the closer an older adult's score is to at-risk boundaries of losing the identified physical function component such as balance, the higher the risk of falls. See Appendix T (Figures 10a-10d) for criterion-referenced standards for 30-SCS, CSR, TUG, and 6MW.

3.8.2. Secondary outcome measures

Secondary outcome measures focused on consolidating internal validity by way of two measures.

3.8.2.1. Record fall incidences

Fall incidences were recorded by each participant in a daily *falls calendar* using the modified definition of a fall (see Appendix U). Falls were defined as an "involuntarily landing on a lower surface or object which includes slipping and landing on a lower surface". This definition is supported by a merger from themes in the literature (PHAC, 2005; WHO, 2007) and was accepted by *all stakeholders.* The definition of a fall was placed within the falls calendar as a reminder and orientation for standardised practice. The falls calendar was reviewed by the Investigator and the *mutual* understanding of what a fall means was clarified during *Meeting#2: pre-assessment day two*. This was essential as the results of the study significantly depend on all participants and the Investigator understanding its definition. Participants were instructed to record incidences by marking an "X" on the day that they experienced a fall. The fall incident was recorded in a critical incident section within the calendar. The description narrative of each fall was imperative for capturing the essential category or type of fall such as injurious fall[14] and especially borderline near falls[15] and non-injurious falls.

Essentially, if a fall is experienced among the residents of the Village of Taunton Mills, a falls incident report is compiled (see Appendix V). After the report is filed, it is archived within a falls registry database. If participants fell during the intervention, they were requested to continue to follow this procedure as well as mark an "X" on the calendar. Therefore, permission to access the falls registry was sought (see Appendix W). The falls registry also provided additional information as to how many falls the participant had experienced within the last two years.

The falls calendars were distributed during the first exercise class and collected by the Investigator during post-assessments. The falls registry database was also reviewed two weeks after completion of the intervention to ensure falls were recorded. Participants were asked not to write their names on the calendars as identification was affirmed by their assigned code. In order to ensure fall incidences did not occur combined with benzodiazepine prescription during the intervention, the subject's medication record was accessed and scrutinised (see Appendix X).

3.8.2.2. Capture exercise behaviours

Capturing exercise behaviours included two parts: (a) obtain reasons for non-

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[14] Injurious falls were defined as minor or major physical bodily harm such as bruises, strains, cuts and/or abrasion, back pain and fractures.

[15] Logghe et al.'s study which defined *near falls* as, "the person seems to fall, but can prevent it by catching or leaning on a person or a thing (e.g. chair, a drawer or a table)". (p. 71)

compliance and (b) confirming participation in other exercise programs. The reason for capturing *non-compliance* will help determine the effectiveness of an exercise program which depends on the ability to keep older adults engaged in exercise. For the purpose of this study, non-compliance is understood as not attending exercise class (more than 3 consecutive classes). The understanding of not attending more than three classes (which was a joint decision among stakeholders) as opposed to another number (e.g. four consecutive classes) was to account for the participants being "busy or occupied" with their daily lives. In order to capture non-compliance data, *attendance sheets* were used during each class (see Appendix Y). The tai chi Instructor was asked to present and collect attendance sheets after each class and at the end of the final class was asked to submit it to the Investigator. If a participant was non-compliant as a result of not attending class, the Kinesiologist overseeing the class would conduct face-to-face or telephone follow-ups. The Kinesiologist would record the reasons for not attending class and verbally state the reason to the Investigator during weekly visits. The Investigator would then record the participants name and reason for not attending and conduct a general discussion during post-assessments. All information discussed during the post-assessments was recorded in the Investigator's diary for analysis purposes. If a participant withdrew from the study (dropout), a verbal explanation to the tai chi Instructor, Kinesiologist or Investigator was needed (if dropout occurred as a result of injury, a procedure was followed that is described in section 3.10). This understanding was clarified among participants prior to the commencement of the exercise program. Additionally, participants were not told to discontinue regular physical exercise routines (if they were doing so) but were asked to verbally report to the Investigator at the last *post-assessment day two* of what exercise classes they were taking part in during the intervention (if any).

3.9. Intervention

The outcome measures are based on the participant's exposure to Yang style tai chi exercise classes within the facility. The 108 form Yang style tai chi intervention consisted of 60-minute classes conducted three times a week over eight weeks for a total of 24 classes. As described in Chapter 2, a general definition of Yang style tai chi is a martial art consisting of slow, rhythmic movements that emphasize trunk rotation, weight shifting, coordination, and gradual narrowing of lower extremity stance. To better illustrate and understand these movements, Figure 11 was retrieved from an online source (Learning tai chi, 2011). Although Yang style tai chi consists of up to 108 forms, no limitation of forms was described in this intervention as the completion of forms was based on the Instructor's assessments of individual and class progression.

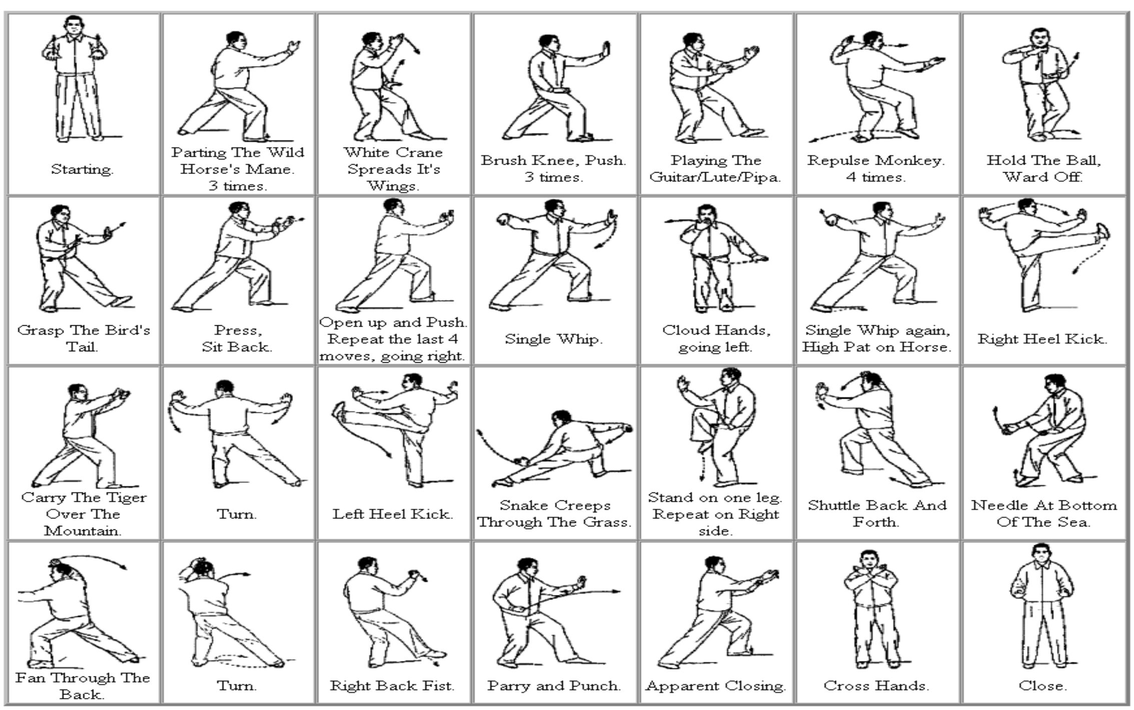

Figure 11. An illustration to demonstrate Yang style movements practiced in the intervention.

A tai chi Instructor who was recruited from the Canadian Tai Chi Academy on a volunteer basis confirmed the movements as presented in Figure 11 and provided a list of names of movements that were practiced or aimed to be in the intervention (see Appendix Z). The tai chi Instructor also provided six guiding principles used by the Canadian Tai Chi Academy that form the basis of movement for each class (see Appendix AA for summary). During the classes, the tai chi Instructor first explained names and movements while demonstrating how the exercise should be performed. The participants then followed the movements, gradually progressing by adding more movements. Participants were not given instructions to practice tai chi outside class time. Those who missed classes did not have make-up classes but the Instructor would review previous lesson at the start of each class.

3.10. Managing risks and dropout

With this vulnerable population, it was essential to manage the potential for both physical and psychological risks. In order to manage the physical risks involved, adequate rest and recovery periods (more than 24 hours) between assessment and exercise classes were followed. This helped participants (a) prevent overuse of fatigued muscles, and also prevent fatigue injuries and falls, (b) enhance cardio-respiratory function, (c) improve functional performance, (d) promote exercise adherence, and (e) limit muscle acidosis (fatigue). However if participants had not recovered prior to the commencement of the following exercise class or assessment day, they had every right to stop and not take part, giving them every opportunity to rest and recover. To further reduce the physical risks, the opportunity for breaks during the intervention was given. If rest and recovery as a form of risk management were not effective, the participants had every right to withdraw (drop out) from the study with reason. Dropouts were defined as participants who were noncompliant or those that verbally withdrew from the study and all data collected regarding dropouts was kept for analysis purposes. If dropouts were a result of an injury, participants were asked to seek aid. Aid was provided on premises as a Physician, Registered Nurse and Kinesiologists were available for treatment throughout the study. If the subject/participant experienced a prolonged injury and wished/opted to return to the intervention, written consent from their physician was needed.

In case of a fall (involuntary landing on the floor) or an accident occurring during a session, the following procedure was followed:

1. Tai chi Instructor, staff or participant identifies a fall or accident.
2. Tai chi Instructor, staff or participant immediately calls a Registered Nurse to the classroom and/or emergency contacts.
3. Charge Nurse/Registered Nurse's (for the day) contact information will be posted at the front of the class, along with 2 emergency contacts.
4. Nursing aid will immediately be provided and, if necessary, 911 will be called.
5. In all cases, the Registered Nurse notifies the family or power of attorney for personal care, and the Physician shortly after the occurrence.
6. If the occurrence is a fall, the tai chi Instructor, staff or participant who discovered the fall is required to fill Section A of the *Falls Incident Report* (refer to Appendix V) located at the Nurses' stations. Section B must be completed by Registered Nurse who attended to the participant. The same

procedure would be followed if the occurrence was a heart attack, stroke, etc. All appropriate forms are found at the Nurses' Stations on premises.

7. Once the form is completed, the Registered Nurse must send it to management.
8. Management receives the report and files it in the appropriate incident binder located in the main office.
9. One of the Kinesiologists will be responsible for locating the incident binder, recording the fall or occurrence and completing the follow-up process.

This information was reviewed with the tai chi Instructor prior to class commencement and was further reviewed by the tai chi Instructor with the participants during the first class. If a fall occurred outside the class, Taunton Mills' pre-existing procedures were used (see section 3.8.2.).

With the intention of managing psychological risks, participants were assured that (a) all information and data were confidential and remained anonymous through the use of the coding system (as described in section 3.7.), (b) results of fall outcomes and physical assessments did not determine overall health, (c) participation within the study displayed their proactive approach against the associated decline in physical function and increased risk of falls due to aging, (d) the tai chi intervention and physical assessments did not act to harm them, but managed their physical function and increased their independence and, (e) the study was not competition-based – rather an assessment of the potential improvement in an individual's physical function capabilities. Participants were reassured by constant verbal feedback from the tai chi Instructor. The Instructor was consistently acknowledging improvement and encouraging participants who were slow to progress during exercise classes.

3.11. Statistical analysis

Data collected from primary outcomes measures (components of physical function before and after the intervention) was recorded and analyzed using the computer software program, Statistical Package for the Social Sciences (SPSS), version 19.0. Descriptive statistics for components of physical function (dependent variables) were presented by Mean (*M*), Standard Deviation (SD), and range. In order to compare means between dependent variables at baseline and follow-up, a paired samples *t-test* was used for analysis and compared to a set *p*-value of $<.05$.

CHAPTER 4

RESULTS

At this stage the results have been demonstrated in sequence and are presented without interpretation or discussion for clarity. The results have been organized into the following sections:

1. *Results of recruitment strategy*: explains how many participants were recruited based on interest (voluntary) and meeting inclusion/exclusion criteria.
2. *Baseline characteristics of participants*: demonstrates information collected prior to pre-test *assessments*.
3. *Results of pre-test assessments:* states baseline results of the instruments used to measure components of physical function.
4. *Exercise intervention and attendance rates*: explains the attendance rate of exercise classes, and the emergence of compliant and non-compliant participants.
5. *Results of assessment measures*: demonstrates results of primary and secondary outcomes measures.
6. *Summary of results*: briefly explains and summarizes findings.

4.1. Results of recruitment strategy

The recruitment strategy was conducted from October 2010 to November 2010 and identified a total sample of 148 older adults. Among the 148 older adults identified, 76 were eligible to participate, 48 were ineligible to participate and the remaining 24 older adults were considered as unknown because their eligibility status was undetermined at the time of recruitment. Among older adults that were considered ineligible (n=48), eight were excluded based on the reported inclusion/exclusion criteria, that is being dependent on a wheelchair (n=3), taking benzodiazepines (n=3), and having a neurological disorder: vertigo (n=1) and Parkinson’s disease (n=1). A total of 19 older adults were self excluded because of lack of interest and did not participate in the study. Regretfully those that lacked interest may have been eligible to participate in the study and could have contributed to robustness of the data set. Of the 76 eligible participants identified after recruitment screening 20 of those eligible opted to be part of the study. However during pre-test assessments one participant withdrew from the study stating disinterest as the reason for withdrawal. Therefore a total of 19 participants were recruited for the study at baseline.

4.2. Baseline characteristics of participants

At baseline, demographic data collected disclosed a participant age range from 65 to 91 years old with an average age of 82.68 years, the majority being between 80-84 years old (n=7). There were 11 females (58%) and 8 males (42%), five used a walker (walking aid), with no participants reporting a fall within the last two years. Table 8 has been developed to illustrate general baseline characteristics of participants expressed by Mean (*M*) and Standard Deviation (SD) or total number (#) where indicated.

Characteristic	Intervention (n=19)
Age (years)	82.68 ± 6.2
60-64	0
65-69	1
70-74	1
75-79	2
80-84	7
85-89	6
90-94	2
Males (#)	8
Females (#)	11
Weight (lbs)	162 ± 33.92
Height (m)	1.66 (5’5½) ± .09
Number using a walking aid (e.g. cane, walker)	5
# of falls within the last two years	0

Table 8. Baseline characteristics collected and represented by *M*± SD or total number (#) where indicated.

4.3. Results of pre-test assessments

After baseline data was collected, pre-test assessments were conducted. The results of pre-test assessments of components of physical function among all participants have been summarized in Table 9. The first column identifies the assessment tool used with the associated targeted component of physical function in parenthesis. The remaining columns identify data results represented by Mean (*M*) plus/minus Standard Deviation (SD): *M* ± SD and test of significance with *p* value set at <.05.

Assessment tool (physical function)	Pre-test (n=17)
BMI (body composition)	25.90 ± 3.45
BBS (static and dynamic balance)	42.41 ± 9.51
30-SCS (muscle strength and endurance)	8.24 ± 3.47
CSR (flexibility)	-1.47 ± 4.86
TUG (mobility)	15.53 ± 6.67
6MW (aerobic endurance)	361.71 ± 151.43

Table 9. Results of assessment tools used to measure physical function components at baseline (pre-test) among all participants that completed the study.

It is important to emphasize these results are presented as a baseline assessment of 17 participants as compared to the initial 19 participants that were recruited. The reason for fewer participants is, over the course of the exercise program two participants dropped out (to be later explained) and as a result 17 participants completed post assessments. Of these 17 participants, a distinctive aspect emerged where participants were either compliant or non-compliant to the exercise program (to be later explained).

4.4. Exercise intervention and attendance rates

Exercise classes began December 10, 2010 and ended February 8, 2011. A total of 24 exercise classes were conducted over a period of eight weeks at a frequency of three times a week (Monday, Wednesday, and Friday). However, the last class was conducted during the following week as no Instructor was available. Figure 12 was developed to illustrate attendance data collected for all exercise classes.

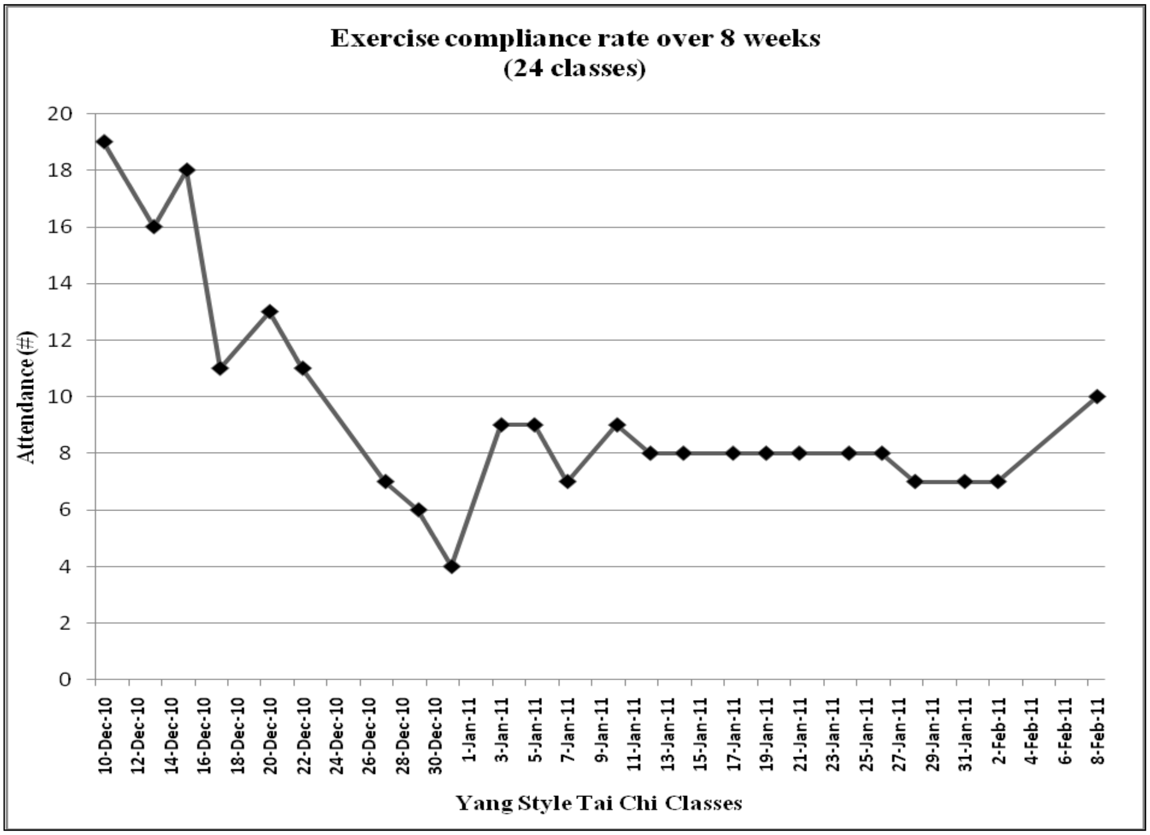

Figure 12. A summary of attendance rates for the exercise intervention.

Of the 24 exercise classes offered, the median number attended by the participants was 8, the attendance range was between 4 to19 and the average attendance was approximately 9. The use of attendance rates was able to further *distinguish* [emphasis added] two groups: (a) *compliant participants*, and (b) *non-compliant* participants. Based on the attendance rates and supported by the previous developed definition for non-compliance (see section 3.8.2.2.), compliant participants were designated as attending at least 21 classes or more (87.5% of tai chi exposure). Non-compliant participants were designated as attending between 1 to14 classes (less than 58% of tai chi exposure).It is important to emphasize the 58% of non-compliant participants includes one participant that sporadically attended 14 classes whereas the remaining participants completed between 1-9 classes. Of the 17 participants, a total of 7 were compliant and 10 were non-compliant. A flow chart has been developed (see Figure in Appendix BB) to clarify and demonstrate participant flow.

4.5. Results of assessment measures

The results of assessment measures have been organized by primary outcome measures and secondary outcome measures.

4.5.1. Results of primary outcome measures

This section will demonstrate post-test results as compared to baseline testing for components of physical function of those that were compliant and non-compliant.

4.5.1.1. Post-test results of compliant participants

The results of post-test measures of components of physical function among those that were compliant (n=7) have been summarized in Table 10. The first column of Table 10 identifies the assessment tool used with the associated targeted component of physical function in parenthesis. The remaining columns identify data results represented by Mean (*M*) plus/minus Standard Deviation (SD): $M \pm$ SD and a p value set at <.05 to demonstrate statistical significance.

	Compliant participants (n=7)	
Assessment tool	**Post-test**	***P* value**
BMI (body composition)	24.91 ± 2.67	.349
BBS (static and dynamic balance)	51.86 ± 4.45	.017
30-SCS (muscle strength and endurance)	12.14 ± 4.53	.021
CSR (flexibility)	.82 ± 2.12	.251
TUG (mobility)	9.84 ± 4.05	.161
6MW (aerobic endurance)	391.86 ± 115.16	.002

Table 10. Results of assessment tools used to measure physical function components at post-intervention among those that were compliant to the exercise program.

Among participants that were compliant (n=7), statistical significance was found between pre-test and post-test measures of static and dynamic balance (p =.017), muscle strength and endurance (p =.021) and aerobic endurance (p =.002). The measurement results for static and dynamic balance, and muscle strength and endurance demonstrated a positive association (improvement) whereas aerobic endurance demonstrated a negative association (regression) after exposure to the exercise program. Other components of physical function such as body composition, flexibility, and mobility did not demonstrate any significant differences and results were relatively comparable to baseline results.

4.5.1.2. Post-test results of non-compliant participants

The results of post-test measures of components of physical function among those that were non-compliant (n=10) have been summarized in Table 11. Similar to Table 10, the first column of Table 11 identifies the assessment tool used with the associated targeted component of physical function in parenthesis. The remaining columns identify data results represented by Mean (*M*) plus/minus Standard Deviation (SD): *M* ± SD and a *p* value set at <.05 to demonstrate statistical significance.

	Non-compliant participants (n=10)	
Assessment tool	**Post-test**	***P* value**
BMI (body composition)	27.65 ± 2.93	.092
BBS (static and dynamic balance)	33.60 ± 11.81	.040
30-SCS (muscle strength and endurance)	8.40 ± 4.25	.136
CSR (flexibility)	-2.55 ± 5.87	.368
TUG (mobility)	16.75 ± 12.61	.195
6MW (aerobic endurance)	241.80 ± 120.73	.004

Table 11. Results of assessment tools used to measure physical function components at post-intervention among those that were non-compliant to the exercise program.

Among participants that were non-compliant (n=10), statistical significance was found between pre-test and post-test measures of static and dynamic balance (*p* =.040), and aerobic endurance (*p* =.004). The measurement results for static and dynamic balance and aerobic endurance demonstrated a negative association (regression) after exposure to the exercise program. Other components of physical function such as body composition, muscle strength and endurance, flexibility, and mobility did not demonstrate any significant differences and results were relatively comparable to baseline results.

4.5.1.3. Pre/post comparison to performance standards

After determining results for pre and post assessments of physical function components, the results were compared to performance standards to determine its relationship to relative physical fall risk. Performance standard scores have been summarized in Table 12 which demonstrates group average ranges of compliant compared to non-compliant participants before and after exercise exposure. Table 12 has been organized by acknowledging participants in "At-Risk" zones for loss of physical function in the specified component.

	Pre-test			Post-test	
	Mean Age	**Mean Score**	**Range of scores**	**Mean Score**	**Ranges of scores**
Assessment tool (physical function)					
BMI (body composition)					
Compliant (n=7)	84	23.6	*	24.0	*
Non-compliant (n=10)	82	27.5	At-Risk	27.8	At-Risk
30-SCS (muscle strength and endurance)					
Compliant (n=7)	84	10	*	13	*
Non-compliant (n=10)	82	7	At-Risk	8	**Normal/ At-Risk
CSR (flexibility)					
Compliant (n=7)	84	1.0	*	1.5	*
Non-compliant (n=10)	82	-3.0	**Normal/ At-Risk	-2.5	**Normal/ At-Risk
TUG (mobility)					
Compliant (n=7)	84	10.7	At-Risk	9.0	At-Risk
Non-compliant (n=10)	82	18.9	At-Risk	17.0	At-Risk
6MW (aerobic endurance)					
Compliant (n=7)	84	483	*	419	*
Non-compliant (n=10)	82	246	At-Risk	234	At-Risk

Table 12. Performance standard scores in relationship to physical risk of compliant compared to non-compliant participants before and after exercise exposure.

**Participants were not in "at-risk" zones*
***Participant is at borderline "at-risk" or there was discrepancy of gender ranges*

The results presented in Table 12 demonstrate the majority of range scores for both compliant and non-compliant participants remained relatively similar before and after the intervention. However participants did move within ranges (e.g. moving from above average to normal) and therefore the validity and significance of individual data rather than group data may be better suited. To clarify, it is generally understood that findings are better presented by average group results; however in respect to the study's sample size and its variability, individual scores better illustrate the importance of performance levels before and after exercise exposure. With this intention, two tables have been developed to illustrate detailed individual results of BMI, 30-SCS, CSR, TUG, and 6MW before (Table 13a) and after (Table 13b) exposure to Yang style tai chi exercise (see Appendix CC). Table 13a shows that before exposure to tai chi, assessments indicated there was a total of 36 components of physical function that were in "at-risk" zones among those that were non-compliant. These were distributed as follows: body composition (6), muscle strength and endurance (7), flexibility (5), mobility (10), and aerobic endurance (6). Table 13b shows after the intervention, a total of 33 components of physical function were in "at-risk" zones. These were distributed as follows: body composition (7), muscle strength and endurance (3), flexibility (6), mobility (9), and aerobic endurance (8).

In contrast, Table 13a shows that before exposure to tai chi, assessments indicated there was a total of eight components of physical function that were in "at-risk" zones among those that were compliant. These were distributed as follows: muscle strength and endurance (2), flexibility (1), and mobility (5). Table 13b shows after the intervention, a total of five components of physical function were in "at-risk" zones. These were distributed as follows: muscle strength and endurance (1), flexibility (1), mobility (2), and aerobic endurance (1).

Also as previously discussed in Chapter 3, BBS is not an element of the SFT and does not provide a reference point for loss of a physical function component but rather it provided a direct measure of fall risk. As a result, a separate table (Table 14) has been developed to illustrate individual results of BBS and the related fall risk among compliant and non-compliant participants. For a better illustration of the influence in exercise exposure, results are separated by those that were compliant (Table 14a) compared to those that were non-compliant (Table 14b) (See Appendix DD). The results indicate the average scores of fall risk of those that were compliant before and after exercise exposure was “low”, where one individual’s fall risk status went from medium to low, demonstrating a positive association (improvement) of balance after the intervention. In comparison, the average scores of fall risk of those that were non-compliant before and after exercise exposure was “medium”. In addition, three individual’s fall risk status went from “medium” to “high” (n=2) and from “low” to “medium” (n=1) demonstrating a negative association (regression) of balance after the intervention.

4.5.2. Results of secondary outcome measure

Secondary outcome measures focused on consolidating internal validity by way of two measures: (a) record fall incidences, and (b) capture exercise behaviours.

4.5.2.1. Results of recording fall incidences

Of the 17 participants that received a calendar and completed post-assessments, one calendar was returned, 12 were reviewed and given back (at the request of the participant), and four were not returned because they were “misplaced”. The falls calendars did not report any fall incidences as all calendars reviewed (n=13) were blank. However, the falls incident report within the registry demonstrated three falls occurred during the intervention but it was not a result of exercise classes rather occurrences experienced at-home while performing ADL (n=2) and outdoors slipping on ice (n=1). The participants who experienced a fall (n=3) attended a combined total of 11 classes, where one stopped attending exercise classes and was not able to complete post-assessments as a direct result of the experienced fall (sustained injury), and the others were disinterested in tai chi and decided not to participate in the exercise but completed post-assessments. Furthermore, after the post-assessments were completed (February 24, 2011), the falls registry database was accessed to review if any falls were recorded. Data collected demonstrated that an additional three falls occurred. Of these three falls experienced among three participants, two were recurrent fallers experienced at-home, one was a new experienced fall at-home, and all were non-compliant but completed post-assessments. Therefore a total of six falls were experienced among four participants, where two participants had reoccurring falls. All participants were non-compliant and of the four, one did not complete post-assessments. In addition, these falls were not a result of side effects from benzodiazepines as the medication list verified no participants were taking these at anytime during the intervention.

4.5.2.2. Capturing exercise behaviours

Capturing exercise behaviours were completed by obtaining reasons for non-compliance and confirming participation in other exercise programs. Of the 11 participants that were considered as non-compliant, all gave explanation for not attending classes as described in Table 15.

Reason for not attending exercise classes	Number of participants
"do not like tai chi because it is too challenging/difficult"	4
"feared falling in tai chi classes as a result of the movements"	1
"personal health-related issues"	2
"busy"	2
"personal reasons"	1
"experienced a fall outside class"	1

Table 15. Reasons given for not attending exercise class among non-compliant participants.

Of the four participants who did not "like" tai chi, one participant dropped out and did not participate in post assessments measures whereas the other three participants completed the study including post assessments although their attendance was not frequent or consistent. During the exercise class period, three participants fell where one was non-compliant as a result of a fall (as stated above), while the other two participants were non-compliant as a result of not liking tai chi and then experienced the fall during the latter portion of the intervention. In addition, participants were asked if they were participating in any other form of exercise classes. Of the 17 participants, three took part in full body resistance training exercises where two of these participants were considered as compliant to tai chi exercise.

4.6. Summary of results

In summary, this chapter demonstrated results of Yang style tai chi exposure on components of physical function. The data analysis of primary outcome measures provided insight to the participant's results after exercising three times a week over eight weeks, totalling 24 exercise classes. It became apparent that participants were either compliant or non-compliant to tai chi exercise. Compliant participants demonstrated significant improvements in static and dynamic balance (p =.017), and muscle strength and endurance (p =.021) and in contrast, demonstrated a significant reduction in aerobic endurance (p =.002) after exposure to Yang style tai chi exercise. Non-compliant participants demonstrated no significant improvements and had significant reductions in static and dynamic balance (p =.040), and aerobic endurance (p =.004) after exposure to Yang style tai chi exercise. When comparing the participants (both compliant and non-compliant) overall result to performance scores in relationship to physical fall risk, the participants demonstrated relatively similar ranges but variability existed in individual characteristics which will be further explained in Chapter 5.

CHAPTER 5

DISCUSSION

This study attempted to answer the question of whether Yang style tai chi is a "one size fits all" fall prevention exercise program for older adults. In order to answer this question, a two-fold hypothesis was tested: a Yang style tai chi exercise intervention practiced by older adults aged 60 years and above will (a) improve components of physical function, which consist of body composition, muscle strength, muscle endurance, aerobic endurance, flexibility, and generalised mobility involving balance, coordination, speed/agility and power, and the anticipated improvements to these components of physical function will (b) reduce the relative physical risk of falling. Thus, a one group pretest-posttest (before-after) experimental design with prospective measures was conducted. Prior to testing the hypothesis by this research design, it was anticipated that the intervention would improve the specified multi variable components of physical function and thereby reduce the physical risk of falls. The results from primary outcome measures demonstrated that the study's directional hypothesis may be partially supported. This chapter explains the reasons for partial acceptance, discusses further findings of the data collected, presents the study's limitations, and provides recommendations for research and community health practice.

5.1. Exercise, components of physical function, and fall prevention

A recent systematic review of 49 studies (Sherrington et al., 2008) pooled the estimate effect of various exercise programs on fall rates among older adults and argued the most effective influence on fall prevention was obtained from exercise programs that challenged balance. In this study, balance was assessed by results of performing the BBS which directly identifies participants in fall risk zones (i.e. low, medium, high). After exposure to the intervention, compliant participants demonstrated a significant improvement in balance. This improvement was established by increasing BBS results from 48 to 52 which aided in maintaining or improving their initial level of fall risk. Ballard et al. argue it is exceedingly challenging for exercise programs to achieve significant improvements when participants have a high BBS score (i.e. near 50) to begin the program because there is lack of room for improvement. However, this intervention was able to effectively challenge balance enough to achieve improvements even with high initial results. In addition, 86% of compliant participants improved their balance results and one participant significantly reduced their risk of falls by moving from medium to a low fall risk. To further justify the intervention's positive influence on balance, non-compliant participants demonstrated a significant reduction in their BBS score, which caused three non-compliant participants to significantly increase their fall risk by moving from medium risk to high risk (n=2) and low risk to medium risk (n=1). This intervention proved to be significantly beneficial for balance, unlike other studies which have reported inconsistent effects of Yang style tai chi on balance (Logghe et al., 2009; Woo et al., 2007).

Suzuki et al. argue that a greater effect of exercise in fall prevention is seen when an exercise program challenges both balance and muscle strength. This argument stems from the results of their study which demonstrated Yang style tai chi exercise in combination with other exercises (e.g. balance training) had a higher significant reduction of fall risk by showing improvements in balance and muscle strength when compared to studies that targeted balance alone. In this study, compliant participants significantly improved their muscle strength after the exercise program by showing a significant progression in the number of stands performed in thirty seconds. The progression in performance was notable among all compliant participants and distinguishable gains were seen among four participants that achieved a higher level of physical function for muscle strength (i.e. moving from normal range to above average). The significant improvement among compliant participants demonstrates a significant reduction in their fall risk by moving away from a loss of physical function for muscle strength and, as Rikli & Jones state, a loss of physical function for muscle strength indicates the highest risk of falls. In comparable contrast, non-compliant participants did not demonstrate an overall significant gain in muscle strength, indicating that those who did show some improvement were likely due to chance. In addition, although it was not reflective in the methodology, notes taken during the assessment process demonstrated those non-compliant participants that improved from baseline stated, “I feel better” or “I am not tired today” as compared to pre-test assessment days. As a result, it may be important to place more emphasis in clarifying subjective fatigue and its relationship to the physical state of older adults prior to the assessments in order to optimize testing, which is theoretically; those that “feel” better may “perform” better. This study was made aware that, it may be of benefit to enhance the findings by using a psychometric assessment tool to survey participant behavioural and cognitive attitudes before and after the intervention, but the study’s purpose was to determine the biophysical aspect and therefore may merit further research. Despite these consequences, Yang style tai chi is shown to be effective by significantly improving muscle strength.

A study by Woo et al. was interested in observing the effect Yang style tai chi has in improving muscle strength and balance to reduce the risk of falls but argued resistance training may be better suited due to its effect in counteracting sarcopenia (i.e. degenerative loss of muscle mass and strength) decline associated with aging. As a result, Woo et al. conducted a study to test the influence Yang style tai chi has in comparison to resistance training. Both exercise programs were practiced three times a week over one year and results demonstrated that r exercise program improved muscle strength or balance and, as a result, did not generate an effect on reducing fall rates. In comparison, this study showed significant improvements in muscle strength and balance using the same style, frequency and a shorter duration than Woo et al.'s study. Furthermore, Woo et al. conclude that Yang style tai chi may not be suitable for improving strength and balance but this study indicated otherwise and may vaguely imply that this intervention is better suited in potentially reversing the effects of sarcopenia decline compared to resistance training.

It is evident that there is variation in the types of exercise programs used to prevent falls which directly relate to the exercise program's aim. Woo et al. argue that the use of resistance training alone directly improves muscle strength which in turn prevents falls due to the effects on the mechanisms related to sarcopenia (which was not further discussed), but did not effectively reduce fall rates. Gillespie et al. argue in order to effectively reduce fall rates and therefore prevent falls, exercise programs should target more than one component of physical function as it was demonstrated that this approach achieved a statistically higher significance in reducing the rate and risk of falling when compared to those exercise programs that did not. A conceptual understanding exists among literature (Ballard et al., 2004; Means et al., 2005; PHAC, 2005; Sherrington et al., 2008; Shumway-Cook et al., 2007) that exemplifies Gillespie et al.'s argument which suggests exercise programs should target balance, muscle strength, flexibility and mobility as these are strong predictors of falls among older adults. To this extent, the intervention adds to the body of literature that demonstrates improvement in balance and muscle strength to reduce the physical risk of falls but the intervention was unable to replicate the results for flexibility and mobility.

At post-intervention, compliant participants compared to those that were non-compliant indicated there was no significant influence in flexibility in either group. Moreover, when looking at performance standards to determine loss of physical function for flexibility, range scores of compliant participants before compared to after the exercise program remained unchanged. Although compliant participants slightly improved lower body flexibility, and non-compliant participants slightly reduced lower body flexibility, a strong determination that the intervention improves flexibility cannot be made because improvements did not reach statistical significance nor did participant's transition into better performance range score to lower their risk of falls. Li et al.'s study indicated that after practicing Yang style tai chi, older adults had considerable improvements in both flexibility and mobility, and the compounded improvement contributed to the significant reduction in falls. In this study, the results for mobility scores of those that were compliant compared to results of those that were non-compliant indicate both were at risk for loss of functional mobility prior to the intervention and therefore had a heightened risk for falling. After the intervention, mobility did improve for compliant participants but this improvement did not reach statistical significance and in addition, majority of participants (75%) stayed in their respectful performance range scores maintaining their level of fall risk. It is a possibility that if compliant participants continued the exercise program, it may have shown a positive progression in mobility but because 66% of those that were non-compliant also improved their scores, a conclusive relationship cannot be made (the progression of duration will be later discussed).

Li et al. argue that there is a correlation between mobility and flexibility, where a reduced range of motion restricts an older adult's mobility and causes instability which increases their risk of falling. Furthermore Li et al., suggest this correlation would imply that exercise influence (an improvement or reduction) for flexibility and mobility would remain similar which was seen in this study and among others (Freiberger et al., 2007; Iwamoto et al., 2009; Means et al., 2005). However, studies (Freiberger et al., 2007; Iwamoto et al., 2009; Means et al., 2005) demonstrated that improvements in flexibility and mobility measures significantly reduced fall risk by employing non-tai chi exercise programs. However, these exercise programs used tailored approaches by designing the interventions to specifically focus on improving targeted preset components such as mobility and flexibility. For example, Means et al. assessed an exercise intervention that was designed for rehabilitation purposes to improve mobility and as a result mimicked mobility movements commonly required to perform ADL (i.e. picking up an object off the floor and placing it in a designated spot). Tai chi is not a customized exercise intervention and it is likely that the characteristics practiced within this study were not able to challenge flexibility and mobility enough to demonstrate significant improvements.

The particular characteristics of Yang style tai chi exercise emphasize low to moderate intensity, up and down movements, postural alignment, and control over one's displacement of body mass. These characteristics may be part of a larger mechanism responsible for the results of this study. For example, the up and down movements may have had a direct result on significantly improving lower body muscle strength by stimulating contractions in the specific muscles (i.e. quadriceps) of the lower body, whereas the lack of extension of the legs during the initial sets of movements (forms) may have resulted in the lack of improvement in lower body flexibility. Li, Harmer, McAuley et al. (2001) argue that, the longer the duration and exposure of tai chi, the more of an effect it has on physical function because the level of difficulty/intensity progresses by performing more forms. This study did not have a restriction in the number of forms but was limited by its duration of the intervention. However, participants were able to complete 27 forms at a frequency of three times a week over eight weeks which proved to be beneficial for muscle strength and balance. In contrast, Logghe et al. limited their Yang style tai chi intervention to 10 forms practiced once a week over thirteen weeks and did not demonstrate improvements in balance nor did it reduce falls rates. Additionally, Woo et al. demonstrated that practicing 24 forms for over a year (static exercise over a longer duration) did not demonstrate improvements in balance, flexibility or number of falls. Therefore it may be justified that the longer one progresses in movements of tai chi, the more of an effect it may have on components of physical function such as flexibility and mobility. Wu et al. suggest that it may possibly take a minimum [*emphasis added*] of 152 classes (three times a week over a year) to "learn" and therefore "master" tai chi forms in order to achieve its "true" beneficial physical effect.

Therefore, future research may consider a longitudinal experimental design with multiple assessment points to determine the optimal number of forms, duration and intensity to practice in order to establish improvements in components of physical function. This is critical to the understanding of how Yang style tai chi as well as other styles has the potential to be an effective fall prevention program for older adults.

The emergence of practicing more forms and increasing duration as a salient characteristic of tai chi in order to improve physical function may have also contributed to the lack of improvement for aerobic endurance. For example, the low to moderate intensity practiced within the 27 forms may not have placed a sufficient enough demand on the cardiovascular system to provide improvements in aerobic endurance. Wu et al. argue it is important to shorten the forms (e.g. 10, 24) to ensure low intensity of tai chi as it serves as an attraction to engage older adults, but this may result in the lack of improvement in aerobic endurance. This is further evident as a recent meta-analysis (Taylor-Piliae & Froelicher, 2004) of the effectiveness of tai chi exercise (in its various styles) in improving aerobic endurance among older adults concluded that the greatest benefit was seen from Yang style tai chi exercise after performing 108 forms over a course of a year. This further justifies the role that number of forms, duration and intensity play in the influence tai chi has on components of physical function which merits further research related specifically to fall prevention. However, a salient finding emerged (discussed below), that may be more important for future research to determine for fall prevention than the characteristics of a tai chi exercise program.

It was unexpected that both groups of participants within this study demonstrated significant reductions in their aerobic endurance where three compliant participants significantly increased their fall risk by declining from above average to normal range (n=2) and below average to loss of physical function for aerobic endurance (n=1). Although it is proposed that the lack of sufficient demand on the cardiovascular system increased compliant participant's risk of falls it became challenging to determine the underlying mechanism. The underlying mechanisms that demonstrate the relationship of aerobic endurance to falls posed to be challenging as retrieved Yang style tai chi studies did not target aerobic endurance. Furthermore, the same meta-analysis presented above (Taylor-Piliae & Froelicher, 2004) demonstrated that, of 441 citations obtained; only seven focused on aerobic endurance in response to exercise and of these seven studies none demonstrated an association to fall prevention. Similarly and to compare, among non-tai chi exercise programs (Freiberger et al., 2007; Shumway-Cook et al., 2007; Skelton et al., 2005) retrieved for this study, no study clearly demonstrated the relationship of aerobic endurance for fall risk reduction. PHAC vaguely argues that the progressive decline in aerobic endurance may lead to impaired regulation of blood pressure which may further lead to fatigue and fatigue decreases an older adult's ability to maintain balance. The decreased ability to maintain balance in turn leads to an increased risk of falling. If this complex inference is true, then why have majority of fall prevention exercise programs not evidently targeted aerobic endurance? A tentative answer to this question will be presented but it is important to emphasize other components that have not been directly and commonly targeted.

Before analyzing other components that have not been targeted, it is important to emphasize that this study's strategic process aimed to first identify fall prevention exercise programs, and then determine what components of physical function the exercise programs targeted. This further justified and confirmed that the components of physical function suggested by Rilki & Jones in relationship to this study's framework were accurate. In order for a fall prevention exercise program to *target* components of physical function, the study would have to measure the component of physical function or the exercise program would incorporate it within their intervention (e.g. balance training resulted in targeting balance) (refer to section 2.3.2 for clarification).

It has been indicative within the literature reviewed for this study that components of physical function such as aerobic endurance, body composition and muscle endurance and their relationship to falls are not evident. This indication is further exemplified within Figure 5 which was created to demonstrate what components were targeted among fall prevention exercise programs. This study incorporated these neglected components because they were identified as elements of physical function and the understanding of a decline in physical function results in an increased physical risk of falls, which is supported by the *Fall-related Physical Function Framework*. It was expected that the literature reviewed would justify the reasons (mechanisms) for the inclusion of their targeted components of physical function, and although majority referenced research for balance, muscle strength, flexibility and mobility it was not done so for aerobic endurance, and especially body composition and muscular endurance.

Some studies have demonstrated an association between increase BMI (as a measure of body composition) and injurious falls (Richardson, 2002) and decrease BMI and risk of fall injury particularly fractures (Meyer, Tverdal, & Falch, 1995). However, among retrieved literature, three studies (Ballard et al., 2004; Iwamoto et al., 2009; Skelton et al., 2005) measured body composition as a baseline characteristic and were set to determine the exercise program influence on weight specifically. The relationship of body composition was not directly identified as a component of physical function or a physical risk factor of falls. In this study, after analyzing data collected in relationship to physical fall risk among compliant participants, their scores did not change and were within a healthy BMI range of 19 kg/m^2 to 26 kg/m^2 demonstrating a low risk of mobility problems before and after the exercise program. The average BMI score of non-compliant participants did not significantly change and remained relatively similar after the exercise program. However, non-compliant scores did indicate an increased risk of loss of mobility which theoretically heightens an older adult's fall risk (Rikli & Jones, 1999a). However a similar question as suggested for aerobic endurance arises: what is the underlying mechanism of body composition that may reduce the risk of falls? Specifically, is there a definitive relationship between height, weight, percentage of fat and muscle mass to fall risk among older adults? Gallagher et al. (2000) argue that a cumulative loss of muscle mass altered by aging body composition results in decreased muscle strength, increased weakness and fatigue, and a reduced ability to perform ADL which may lead to increased risk of falling among older adults. If this inference is true, why have fall prevention exercise programs not evidently targeted body composition?

As far as targeting muscle endurance, only two studies (Ballard et al., 2004; Shumway-Cook et al., 2007) incorporated this component of physical function but showed no improvement nor was there a significant reduction in falls. This study used the same assessment measures as Shumway-Cook et al. which couples muscle endurance with muscle strength but found results varied. The variation between the two studies was in the interventions used, where Shumway-Cook did not find significant improvement in muscle strength and endurance when investigating an exercise program that included fitness training such as weight lifting, yet this study's intervention demonstrated contrary findings using Yang style tai chi by significantly improving muscle endurance. Muscle endurance became challenging to address as only Ballard et al. demonstrated that muscle endurance should be distinguished from muscle strength, but again did not demonstrate its underlying mechanism in relationship to falls. Thus, the elusive question still remains: why have fall prevention exercise programs not evidently targeted certain components such as aerobic endurance, body composition, and muscular endurance? The answer may be in the paucity of literature and studies performed explaining the underlying mechanisms for aerobic endurance, body composition and muscle endurance and their relationship to falling among older adults when compared to other components. This is evident as PHAC suggests that strong predictors of fall risk factors among older adults include balance, muscle strength, flexibility and mobility but research is needed to identify other possible physical risk factors. This research has identified other potential factors as a result of its link to physical function but additional research is warranted to determine the underlying mechanisms that influence falls to further strengthen its relationship with prevention.

This study, guided by the *Fall-related Physical Function Framework* in an attempt to determine the influence of Yang style tai chi on all components of physical function and fall prevention has essentially generated more questions than it attempted to answer. For instance, this study did not seek to determine what the underlying mechanisms were for components of physical function because it is argued that a decline in overall physical function (i.e. inability to perform ADL) in itself is a physical risk factor of falls (PHAC, 2005; WHO, 2007). However, this study did identify elements that are comprised of physical function and, by doing so, has initiated an inquiry that is imperative to address when conducting further research studies. This research is critical to have a better understanding of how positively effecting the components of physical function can optimally aid in the prevention of falls. This inquiry emerged from the developed *Fall-related Physical Function Framework*. The framework builds upon literature that targeted components of physical function within fall prevention exercise programs. The framework was then used to derive the hypothesis which was created to answer the research question: is Yang style tai chi a “one size fits all” fall prevention exercise program? The findings, based on the hypothesis, suggest that Yang style tai chi is moderately effective as a fall prevention exercise program as it improved balance, muscle strength and endurance but did not improve other components. Details as to why there were no significant impacts (both negative and positive) on components such as flexibility, mobility, aerobic endurance and body composition indicate a need for further detailed research.

This research offers a framework that provides a standardized measure of physical fall risk which is more comprehensive than previous work. For example, Lin et al. only targeted balance and did not demonstrate a significant reduction in fall risk and, although balance is a strong predictor of falls, their lack of targeting other components of physical function may have influenced their inability to determine a broad based model that provides statistical significance in preventing falls. This standardized measure as an approach for fall prevention is critical because by identifying the main possible indicators for increased physical risk of falls through a decline in the influential factors that encompass physical function, we may be able to determine the profile of an optimal fall prevention exercise program. Yang style tai chi in this context did not demonstrate to be an optimal fall prevention exercise program but, it may have the potential to be if certain characteristics of tai chi are enhanced (such as increased duration to improve aerobic endurance). If future research uses this framework as a guide while attempting to determine characteristics of tai chi to strategically improve all components of physical function, it may be able to achieve a significant impact on decreasing physical fall risk. This study was not able to totally confirm this proposition as a result of its limitations however the findings presented in this framework provide directions for future research to determine which types of exercise programs are most *effective* and how to *optimize* an exercise program for fall prevention for older adults. Therefore although there is a long way to go in terms of strengthening this framework (such as determining underlying mechanism for components of physical function and its relationship to falls), it is proposed that further research utilizes this framework as a means to effectively decrease the physical risk of falling through increases and strengthening of the components of physical function which have been determined to be major contributors to physical fall risk. Specific recommendation for research as well as community health practice will be discussed in section 5.3 and 5.4 respectively. To conclude, this framework provides the insight that is needed and constructed in order to explain, predict and aid in mastering the fall prevention phenomena among older adults as it relates to the comprehensive relationship and synergies between the processes of aging, physical function and exercise.

5.2. Study limitations

This study's findings should to be viewed in light of its limitations. First, the sample size of this study was particularly small. For this reason, these findings cannot be generalized to the broader community, but they did provide valid information for the Village of Taunton Mills. Second, although Weerdesteyn et al. demonstrated significant gains in targeted components of physical function (e.g. balance) from an exercise program conducted over a five-week period, this study period of eight weeks was relatively short and it became evident that long-term tai chi exercise duration may be needed to optimize its beneficial aspects. Third, although efforts were made to strengthen internal validity to meet the study's aim, the design of the study was not considered as a "gold standard" of research where Randomized Control Trials (RCTs) would be of preference; however there was a lack of participants and time required to carry out a RCT. Nevertheless, the one group before-after experimental design demonstrated valuable findings which can be built upon by further research using RCTs. Fourth, although the SFT was beneficial it lacked a true test for muscular endurance. An initial option used to determine muscle endurance was the "wall sit" as described in Ballard et al.'s study but this test was disregarded by stakeholders as past use of the test had negative outcomes (i.e. high injury). Also within the SFT are limitations of using BMI as an indicator of body composition as BMI classification scale was not based on optimal ranges for older adults but it did provide a general understanding of being in healthy ranges. Fifth, the exercise program might have had a greater impact on components of physical function if it had less selectivity of its sample. By potentially targeting older adults with increased fall risks (which were excluded based on delimitation criteria), the exercise program may have had better results but antecedent variables needed to be controlled for internal variance and healthy older adults are also exposed to fall risk. To this end, this study was not able to determine fall risk using Incident Rate Ratio (IRR) or fall Hazard Ratio (HR) as presented within majority of retrieved literature because the sample of older adults had a zero prevalence of falls (i.e. no experienced fall within the last two years). However, this method may have its limitations as majority of retrieved literature did not isolate recording incidences of falls as directly related to physical risk. For example, Iwamoto et al. measured fall risk by IRR which was based on fall incidences three months prior; however, the context of the fall incidence was not described. As a result the fall may have been related to other factors, such as environmental (e.g. slippery surface), rather than the influence of physical risk factor which was this study's primary focus.

5.3. Recommendations for research

This study guided by its framework provides a valid foundation for other similar studies but warrants further work. Therefore this section intends to specifically provide recommendations for future direction to build upon its findings.

5.3.1. Apply the framework to determine underlying mechanisms and possible correlations between components

It became evident that the comprehensive approach of identifying and investigating age-related components of physical function and determining how they may be influenced by a Yang style tai chi exercise as a fall preventative exercise program are novel areas of interest. However, further research is needed to address three questions. First, why have fall-prevention exercise programs such as Yang style tai chi not targeted all components of physical function to reduce falls and have specifically not targeted body composition, aerobic endurance, and muscle endurance? It is possible that this is in large part due to the lack of literature demonstrating each component's underlying mechanisms in preventing falls. For example, to demonstrate balance mechanisms and falls retrieved literature (Shumway-Cook et al., 2007) has cited Berg (1989) who suggests age-related changes in the vestibular system may have an effect on the capacity to resolve inter sensory conflict and this conflict increases an older adult's risk of falling because it interferes with the ability to balance effectively. To this end and secondly, what are the underlying mechanisms for neglected components such as aerobic endurance that cause falls? Some possible solutions were presented but remain vague and thus the answers to these questions need to be solidified to possibly determine how an exercise program can influence these specific mechanisms in order to effectively reduce the physical risk of falls among older adults. Third, is there a correlation between components of physical function? It is a possibility a correlation exists between components that are determined by their underlying mechanisms. For example, the understanding that an older adult may be at an increased risk of falls due to inability to counteract sarcopenia which reduces both muscle mass and strength, effecting body composition and muscle strength respectively. Therefore, it is recommended that future research use the framework as a theoretical model to analyze the possible correlation between physical risk factors of falls (components of physical function).

5.3.2. Build upon tai chi characteristics to determine an optimal approach

It remains evident that further inquiries are required to minimize the gaps and inconsistencies among tai chi literature as it relates to fall prevention. Until more research is conducted with a standardised methodology, a conclusive answer cannot be given to whether tai chi is an effective fall preventative exercise program for older adults. However, if further research builds upon tai chi characteristics to determine an optimal approach for preventing falls, tai chi has the potential to be a "one size fits all" solution because, in theory, tai chi may have a latent effect in improving physical function since related literature has not directly focused on targeting the multi variable components of physical function. This may be cause for further controlled and systematic evaluations of the characteristics of tai chi and the need for better understanding of the integration of physical functioning and its relationship in the execution of tai chi movements within various styles. This recommendation is important to (a) determine whether tai chi is an optimal fall prevention exercise strategy by providing increased knowledge of how various tai chi characteristics (i.e. style, duration, etc.) can improve the age-related decline in the components of physical function and therefore prevent falls and (b) to open opportunities to use and further strengthen the *Fall-related Physical Function Framework* as an integrated approach in the analysis of fall prevention exercise on the multi variable components of physical function.

5.3.3. Determine exercise interest and attitudes towards tai chi to increase program acceptance and engagement

It is apparent from the lack of participants and specifically from attendance rates (see Figure 12, p. 79) that interest in tai chi is particularly variable. The most reported reason given for lapses in exercise class attendance was that participants did not like tai chi because they specifically could not memorize the movements. Although classes were compressed by being more frequent over less time, participants still found it challenging to memorize movements. Also, one participant feared falling within the tai chi class as a direct result of the movements. Existing literature demonstrates that tai chi reduces the fear of falling (Sattin et al., 2005), but it may be important to explore why participants may not engage in tai chi exercise (i.e. exercise attitudes towards tai chi), as it may be a burden on memory or a fear of practicing tai chi itself that deters older adults from participating. This may be a broad possibility as to why there was a lack of interest in participating in the tai chi program during the recruitment phase. Specifically, during the presentation to recruit participants, a video was shown of Yang style tai chi movements. A general consensus emerged among those that attended the presentation that the movement demonstrated in the video would be difficult to memorize and perform. It is important to emphasize that the lack of participants and compliance rates may be attributed to the intervention being conducted during the holiday season (i.e. Christmas and New Years), but even with a safe, practical and short-term community-based tai chi program, program acceptance and engagement were still concerns. In contrast, compliant participants looked forward to enrolling in further tai chi classes offered after the completion of the research study as a result of enjoying the social environment and benefits the exercise provided them (e.g. improved posture). It is likely that a fear of falling through tai chi movements and motivational indicators exist as contributors to the lack of compliance and barriers to participation, and although this study was made aware of this, it was not its aim. Therefore, it is recommended that future research conduct a qualitative study to (a) explore the attitudes towards Yang style tai chi exercise specifically (as each style has different characteristics), and (b) establish what factors influence older adults to participate in tai chi as a fall prevention exercise program in order to effectively increase engagement and program acceptance/commitment. This is especially noteworthy as all participants completed their final testing and, when asked why, they answered by stating they wanted to know if they improved from baseline measures. This demonstrated commitment to their physical function status, but not necessarily to the tai chi exercise program.

5.4. Recommendations for community health practice

An essential aspect in determining the effectiveness of a community-based tai chi exercise program is community support to aid in maximizing research and program acceptance. PHAC suggests that community-based exercise programs often rely on networks that extend beyond its community, such as advocates and stakeholders from research organizations such as universities. Minkler further states that sustainable programs are most successful when organizations integrate CBR based projects into their broader organizational goals, so that initiatives can, in turn, support the broader mission of the organizations. The primary goal of the research study for the Village of Taunton Mills was to meet RIA's mission "...to enhance the care of older adults in both community-based and Long Term Care environments through the development and implementation of innovative research and training programs." (RIA, 2011). Although the primary focus of this research was to demonstrate the influence Yang style tai chi has on physical function, it became essential to provide recommendation for community health practice to provide means for enhancing the care for older adults.

5.4.1. Apply the framework as a tool to manage physical fall risks

In order to manage physical fall risks, the framework may be used as a tool by healthcare practitioners to identify and monitor components of physical function that may need addressing, such as balance, in order to prevent older adults from falling, and experiencing recurring falls. Within this study, three participants who completed pre- and post-assessments fell. Upon further review, the assessments indicated that the fallers had a loss of physical function for specific components, which heightened their risk of falls. For example, a faller showed that their fall risk was low based on their balance result, however, their aerobic endurance and flexibility were at critical levels (i.e. below the cut-off point), which heightened their fall risk. Therefore, it would be beneficial to recommend that this individual incorporate an exercise that emphasizes improving aerobic endurance and flexibility. Another example for the tool to manage physical fall risk can be exemplified in a particular faller who had recurring falls. This participant had very low levels of mobility and aerobic endurance shortly after the fall (fell close to post intervention), which likely indicates that a rehabilitation program that improves these components would be beneficial for preventing further falls. This leads into the possibility of using the framework as a tool for both tailored approaches for those with identified physical fall risk (components of physical function) and the creation of rehabilitation programs which aim to remove identified physical risk factors among recurring fallers. The identification and monitoring aspects of implementing this framework educate healthcare practitioners on how to possibly prevent falls by lowering physical fall risk via identifying the variable that most affects physical function. In addition, the identification of components of physical function builds awareness for the individual regarding their own physical fall risks

5.4.2. Clarify and have a mutual understanding of a fall

It was discouraging to observe that during the post-intervention follow-up, a total of six falls were reported among four non-compliant participants, where one categorized as injurious and the remaining were non-injurious. Although the fall incidences were not a direct influence of the intervention, especially since they occurred among non-compliant participants, the heightened result of reporting falls could be influenced by clarifying the definition of a fall prior to the intervention. As demonstrated in Chapter 2, if fall prevention is an objective of an exercise program, then the inclusion and mutual understanding of a fall are imperative. While establishing a clear and mutual understanding of a fall during the onset of the study, it became evident participants were not familiar with categories of falls (i.e. injurious falls, non-injurious falls and near falls) and how each was defined. Moreover, it is paradoxical that, within the past two years, no participant reported a fall but the sudden spike in reporting may have been influenced by the establishment of a mutual understanding of a fall among participants and by having the definition of the falls as constant reminders on their falls calendar. It is recommended that measures be taken to improve the facility's current reporting system by clarifying the understanding of fall among the facility's residents and further, by having categories, as it is important for fall prevention (i.e. reporting near falls as potential warning signs). This recommendation can be carried out in both practice and research as it is a fundamental aspect among community-based facilities that provide care for older adults (e.g. retirement living homes) and also remains imperative among fall-related literature in order to truly capture and measure fall incidences.

5.4.3. Use performance-based measures as an additional tool to determine physical function

As a result of both BBS and SFT being easy to administer and replicable, general healthcare practitioners are able to use the assessments as a tool to measure and evaluate physical function and identify performance criterion to determine level of fall risk. For example, the BBS can assist the facility's Kinesiologist to assess an individual's balance and interpret their level of fall risk based on the results. Furthermore, participants can use the results for both BBS and SFT as a basis for individual goal-setting and program planning, and as a motivational factor to improve specific components of physical function. These performance-based measures can supplement the current self-report measures of physical function (e.g. Functional Status Questionnaire[16]) within the facility. In the past, the facility has preferred using self-report measures for reasons of cost containment and a limited budget. However, this study did not obtain any costs and operated without a budget, yet still was able to measure all components of physical function without using self-reporting measures. In addition, self-reporting measures may have their limitation as they rely on the respondent's subjective judgement and lacks a rigorous examination of the effects an exercise program may have on physical function as demonstrated within this study. However as previously presented, psychometric assessment tools aid to survey participant behavioural and cognitive attitudes, as well as understand their overall physical state and therefore, it may better suited that health care practitioner's use performance-based in addition to self-reported measures.

[16] Functional Status Questionnaire can be used as a self-administered functional assessment for an older adult to measure their physical functioning (Jette et al., 1986).

CHAPTER 6

CONCLUSION

The impact of falls and fall related injuries among Canadian older adults is astounding, not only in terms of the number of cases, the impact on the healthcare system, reduced personal well-being and quality of life, but most importantly, the vast scope of preventable morbidity and mortality. The growing number of initiatives in Canada such as DAS's strategic plan is encouraging and the ultimate goal of integration into healthcare practice of evidence based initiatives such as exercise interventions appears to be emerging. However, preventative efforts will need to be doubled to keep pace with our rapidly aging population. This includes studies like this which respectively demonstrated novel research to validate existing strategies such as tai chi exercise and initiated a comprehensive approach to investigate the effectiveness of existing and new exercise interventions for the prevention of falls among older adults. It is recommended, moving forward, that future research considers the use of the *Fall-related Physical Function Framework*, as a likely mechanism for fall prevention may be, at least in part, through an improvement in the multi variable components of physical function. The findings of this study indicate Yang style tai chi improves some aspects of physical function and is therefore moderately effective in reducing physical fall risk among older adults living in the community. However, one study guided by this study's conceptual framework is not sufficient to answer all of the questions that need to be addressed. Future research may use this study's findings, recommendations, and strategic comprehensive approach as a foundation for determining the effectiveness of tai chi exercise as a fall prevention strategy. This would aid in increasing tai chi's overall impact factor and, if tai chi proves beneficial in improving the multi variable components of physical function while significantly reducing falls, it will aid in justifying its implementation as an optimal public health strategy for fall prevention among older adults across Canada.

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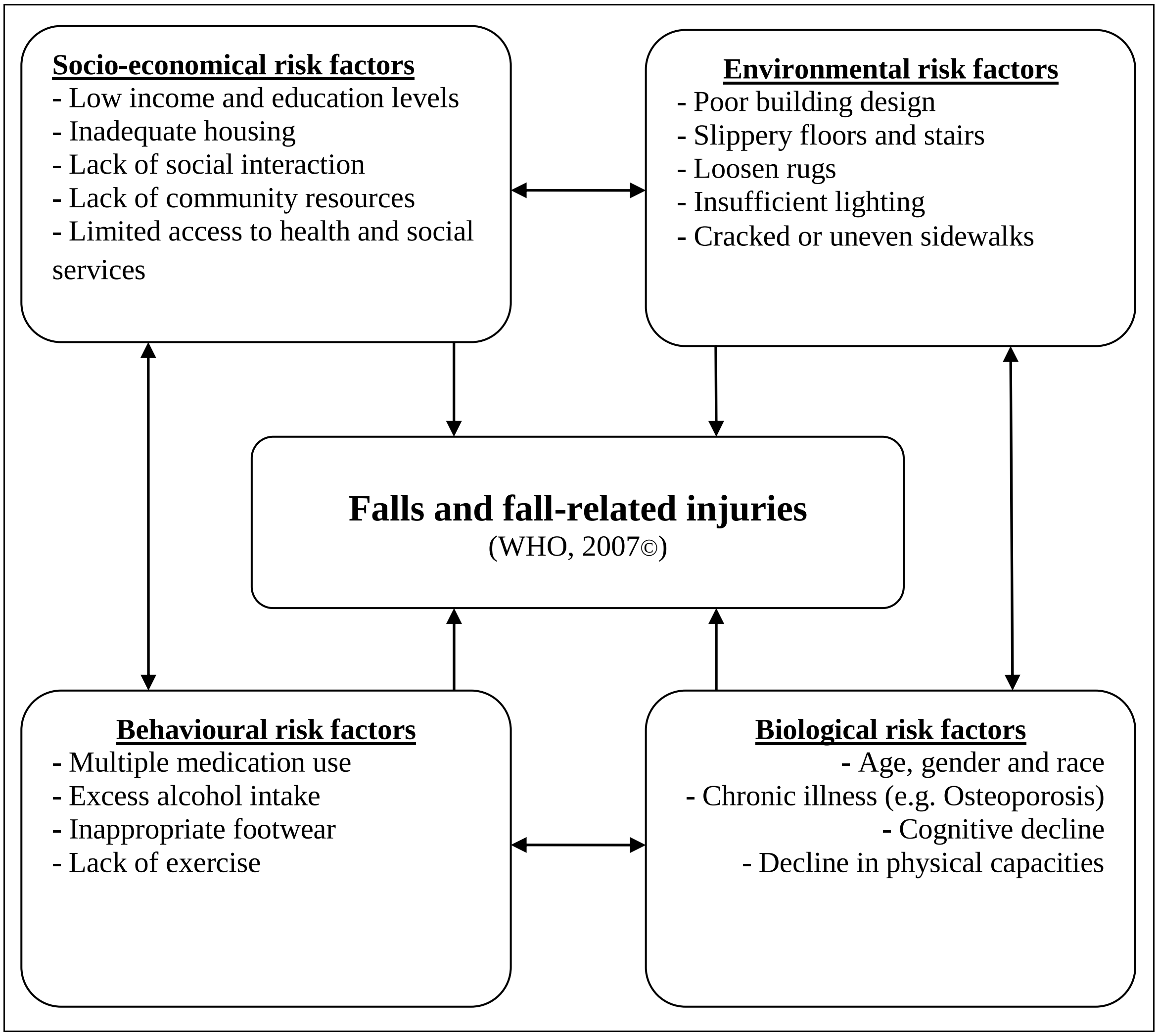
APPENDICES

Appendix A

Figure 1. A Risk Factor Model for Falls in older age (RFMF) by World Health Organization [WHO], 2007, p. 5. Copyright 2007 by the World Health Organization.



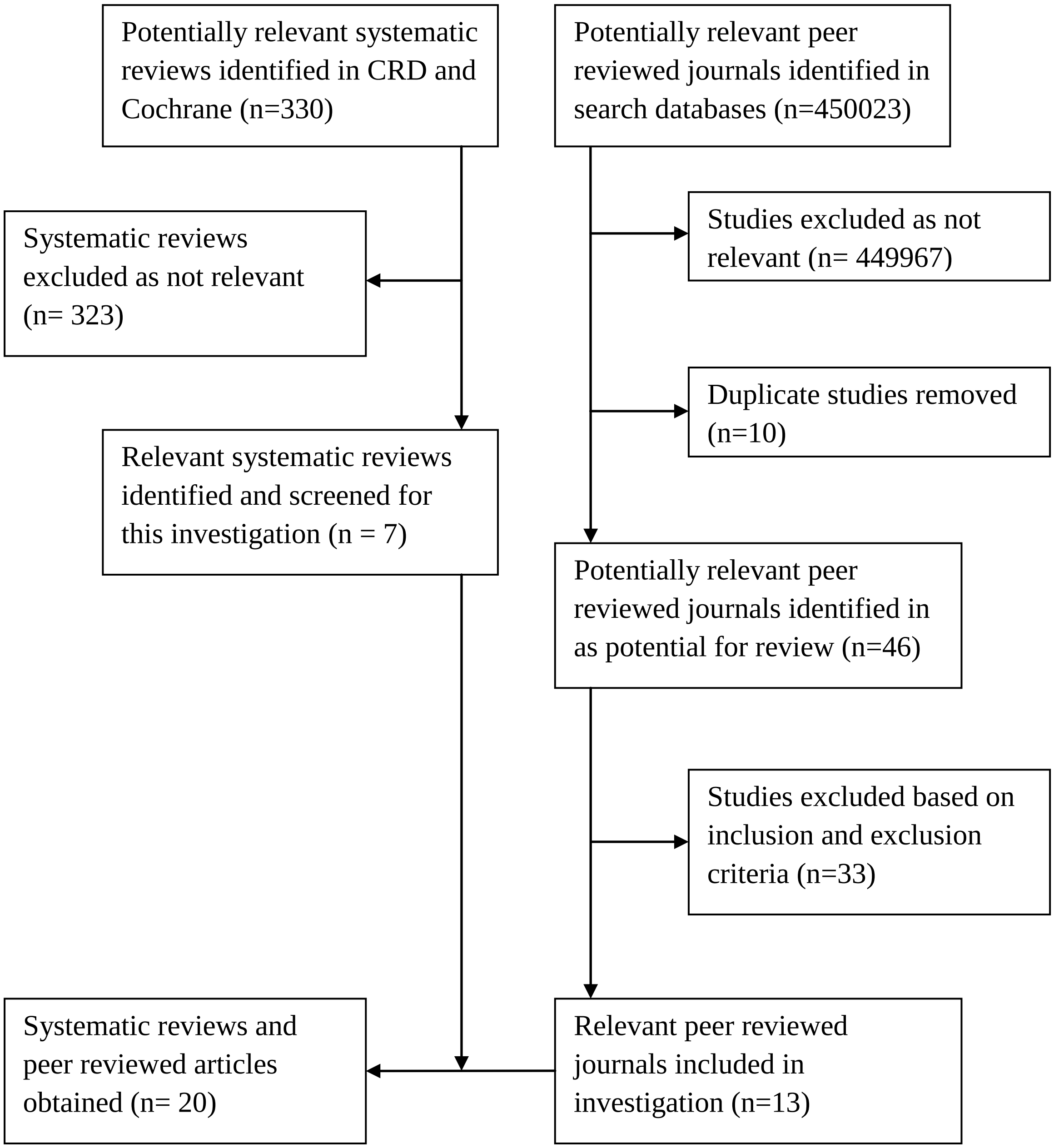
Appendix B

Inclusion and exclusion criteria for literature review selection

Table 1

Inclusion	Exclusion
▪ Older adults aged 60 years and above	▪ Older adults below the age of 59 years
▪ English written literature	▪ Non-English written literature
▪ Most recently published literature (January 2004 to January 2010)	▪ Literature published prior to January 2004
▪ Study’s target population are as follows: - Considered *healthy* (understood as the ability to cope with disabling conditions) - Independently living (understood as living arrangements where there is limited or no assistance with ADL)	▪ Study’s target population are as follows: - Have a degenerative neurological condition which may increase the risk and incidence of falls such as vertigo and Parkinson’s disease. - Under benzodiazepines medication which may impair balance and increase the risk and incidence of falls
▪ Stand-alone exercise interventions	▪ Approaches to reduce falls that are multi-factorial interventions such as exercise programs coupled with home modifications
▪ Exercise programs must incorporate fall prevention (stating or demonstrating it).	
▪ Exercise programs that target at least one component of physical function or measures used focus on at least one component of physical function	

Figure 2. Step-by-step flow chart of systematic reviews and scholarly articles retrieved for review.



Appendix C

General definitions of physical function components

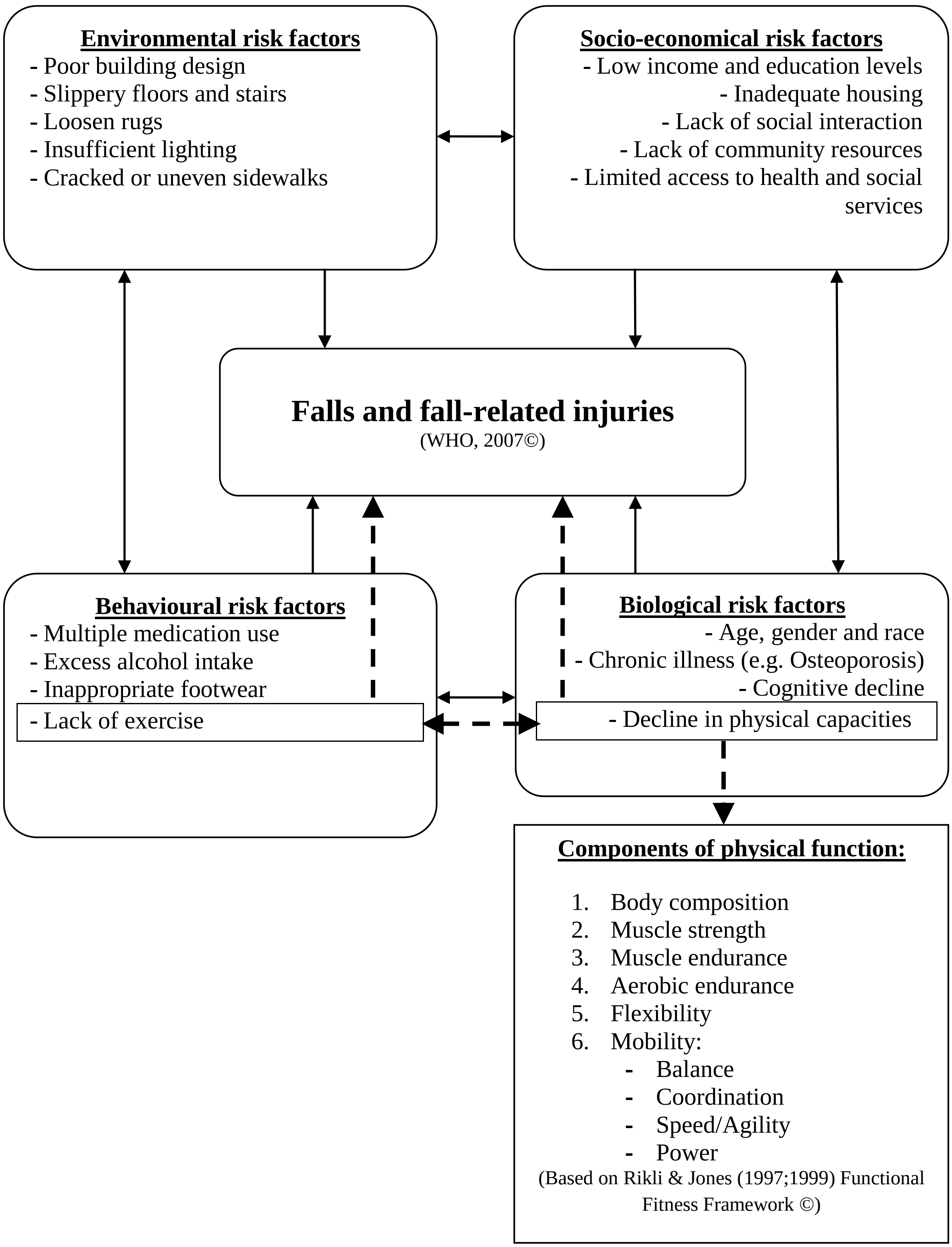
Table 2

The following definitions are by Caspersen et al. (1985). Full reference may be seen in the reference list.

Components of Physical Function	Definitions
Body composition	"…the relative amounts of muscle, fat, bone, and other parts of the body." (p. 129)
Muscle Strength	"…the amount of external force that a muscle can exert". (p. 129)
Muscular endurance	"…the ability of muscle groups to exert external force for many repetitions or successive exertions." (p. 129)
Cardiorespiratory *or* *Aerobic endurance*	"….the ability of the circulatory and respiratory systems to supply fuel during sustained physical activity and to eliminate fatigue products after supplying fuel." To clarify, it relates to stamina such that an individual can maintain maximum duration for a specific activity. (p. 129)
Flexibility	"…the range of motion available at a joint." (pp. 129)
Balance	"…maintaining equilibrium while stationary (static balance) or moving (dynamic balance)." (p. 129)
Coordination	"…the ability to use the senses…together with body parts in performing motor tasks smoothly and accurately." (p. 129)
Speed	"…the ability to perform a movement within a short period of time." (p. 129)
Agility	"…the ability to rapidly change the position of the entire body in space with speed and accuracy." (p. 129)
Power	"…the rate at which one can perform work." (p. 129)

Appendix D

Figure 3. An adaptation of Risk Factor Model for Falls in older age (RFMF) (WHO, 2007) and Functional Fitness Framework (FFF) (Rikli & Jones, 1997; 1999).



Appendix E

Results of retrieved literature for review

Table 3

The literature is organized by exercise as being beneficial (by improving a component of physical function) versus statistical significance in preventing falls (measured by reducing the number of falls and/or reducing hazard, incident rate or risk ratio of falls). Full references may be seen in the reference list.

Wholly supportive	**Partially supportive**	**Unsupportive**
Beneficial with statistical significant reductions in falls	Beneficial with no statistical significant reduction in falls or not evident	Not beneficial with no statistical significant reduction in falls
Freiberger et al. (2007)	Ballard et al. (2004)	Logghe et al. (2009)
Iwamoto et al. (2009)	Lin et al. (2006)	Woo et al. (2007)
Li et al. (2005)	Shumway-Cook et al. (2007)	
Means et al. (2005)	Skelton et al. (2005)	
Suzuki et al. (2004)	Voukelatos et al. (2007)	
Weerdesteyn et al. (2006)		
	Total (%)	
6 (46%)	5 (Approximately 38%)	2 (15%)

Appendix F

Letter of approval from the Village of Taunton Mills

A letter sent to UOIT's REB stating approval of the research study to commence. Non-publicized contact information that was displayed has been removed for confidentiality reasons and "contact" has respectively been written in its place.

To:
Compliance Officer
University of Ontario Institute of Technology
2000 Simcoe Street North
Oshawa, Ontario
L1H 7K4

August 19th, 2010

This letter is to notify you that I have received and reviewed the proposal for the project entitled "**The effect of Yang style tai chi on fall prevention and physical function**" presented by **Rohan Gonsalves and Dr. Manon Lemonde** from the **Faculty of Health Sciences** at the **University of Ontario Institute of Technology**. I have had an opportunity to discuss this project with Dr. Mike Sharratt (Executive Director, Schlegel-UW Research Institute for Aging), and with the continued support of Bob Kallonen (VP of Healthcare Operations, Schlegel Seniors Villages), we are looking forward to Rohan Gonsalves (as the Principal Investigator) and Dr.Manon Lemonde (as the faculty supervisor) working with the staff and residents of the Schlegel Seniors Villages to carry out this important work.

The research team has applied to conduct this study at the following Schlegel Seniors Villages:

The Village of Taunton Mills, Whitby	(General Manager: Rose Lamb)
The Village of Humber Heights, Etobicoke	(General Manager: Stephanie Sanborn)

Please accept this letter as confirmation that this study has undergone a standard review process and has been approved to take place in the Schlegel Seniors Villages listed above, through the Schlegel-UW Research Institute for Aging, with the possibility of moving to their sites as necessary.

Thank you for your continued support of the Schlegel-UW Research Institute for Aging and the Schlegel Seniors Villages. If you have any additional questions or require additional documentation, please do not hesitate to contact me.

Sincerely,

____
"Contact"

cc:	Dr. Mike Sharratt	(Executive Director, Schlegel-UW Research Institute for Aging)
cc:	Bob Kallonen	(VP of Healthcare Operations, Schlegel Seniors Villages)
cc:	Rose Lamb	(General Manager, The Village of Taunton Mills)
cc:	Stephanie Sanborn	(General Manager, The Village of Humber Heights)

Appendix G

Information package: cover letter, information letter, and interest form

Information packages that were mailed to each participant consisting of three parts: (a) cover letter, (b) information letter and (c) interest forms. Non-publicized contact information that was displayed has been removed for confidentiality reasons and "contact" has respectively been written in its place.

Schlegel-UW Research Institute for Aging

COVER LETTER

The Village of Taunton Mills
The Village of Humber Heights

THE EFFECT OF YANG STYLE TAI CHI ON FALL PREVENTION AND PHYSICAL FUNCTION

With approval from General Manager Rose Lamb, The Village of Taunton Mills is collaborating with the Schlegel-UW Research Institute for Aging to complete a research study as part of the **Functional Abilities Program.** During the month of September 2010, **Dr. Manon Lemonde** and her graduate student, **Rohan Gonsalves** will begin their study on-site in the retirement home at Taunton Mills. Dr. Lemonde will be the Supervisor of this research and is from the Faculty of Health Sciences at the University of Ontario Institute of Technology. Rohan Gonsalves is a Certified Kinesiologist and will be the principal investigator. He is currently completing his Masters in Health Sciences at the University of Ontario Institute of Technology.

The purpose of this study is to examine if regular participation in tai chi classes will enhance physical function to the point of reducing the risk and resultant number of falls in a group of older adults. Falls are a major concern in older adults. Not only do they often result in a loss of independence and mobility for the individual who has fallen, but they also put a tremendous strain on the healthcare system in Canada. Therefore, it is important to understand those programs and services that might serve to reduce the risk of falling for older adults. There is relatively little research done in the area of falls and exercise. If this study shows that regular participation in tai chi classes enhances physical function to the point of reducing the risk and resultant number of falls in a group of older adults, this study has the potential to influence the type of physical activity programming that the Recreation Department and Functional Abilities Program offer to the residents living at Taunton Mills as well as the other Schlegel Seniors Villages across south-western Ontario. It will also contribute much needed information to the scientific community on this topic.

The Schlegel-UW Research Institute for Aging (RIA) brings top researchers from across Canada to study the aging process with the participation of staff and residents in the Schlegel Seniors

Villages. The overall goal of the RIA is to enhance the care that residents receive in both long-term care, retirement homes, and in the broader community through research and training. The RIA only supports research with direct application to practice and care.

This package contains a detailed description of the project for you to review. Once you have reviewed the information letter, **please complete the *Participant Interest Form* (yellow page) and return it to the main office at Taunton Mills in the envelop provided.**

If we have not received your form after two (2) weeks, I will follow-up with you to answer any questions that you might have. In the meantime, please do not hesitate to contact me directly at any time.

Sincerely,

____

"Contact"

CC:	Rose Lamb	(General Manager, The Village of Taunton Mills)
CC:	Lauren Guthrie	(Functional Abilities Program Kinesiologist, The Village of Taunton Mills)
CC:	Dan Kennedy	(Functional Abilities Program Kinesiologist, The Village of Taunton Mills)
CC:	Jaimie Killingbeck	(Functional Abilities Program Coordinator, Schlegel Seniors Villages)
CC:	Mike Sharratt	(Executive Director, Schlegel-UW Research Institute for Aging)
CC:	Bob Kallonen	(VP Healthcare Operations, Schlegel Seniors Villages)
CC:	Rohan Gonsalves	(Principal Investigator)
CC:	Manon Lemonde	(Faculty Supervisor)

Schlegel-UW Research Institute for Aging

INFORMATION LETTER

The Village of Taunton Mills
The Village of Humber Heights

THE EFFECT OF YANG STYLE TAI CHI ON FALL PREVENTION AND PHYSICAL FUNCTION

You are being invited to participate in a research study. To decide whether or not you want to be a part of this research study, you should be aware of what is involved. This information letter gives detailed information about the research study, which will be discussed with you. You will be asked to complete the attached form (yellow) once you have made your decision.

Please take your time to make your decision.

If you have any questions about this process, please do not hesitate to contact:

"Contact"

PURPOSE AND SIGNIFICANCE OF THE PROJECT

Falls are a serious public health problem and have been identified as one of the major causes of morbidity and mortality in older adults aged 60 and above (Public Health Agency of Canada [PHAC], 2005). Facts about falls:

- It is estimated that one third of generally healthy community living older adults fall once a year (PHAC, 2005).
- Almost half of older adults who fall experience a minor injury and 5% to 25% sustain a serious injury (Division of Aging and Seniors [DAS], 2007).
- Experiencing a falls may lead to hospitalization (Registered Nursing Association of Ontario [RNAO], 2002)
- In Ontario, falls are the leading cause of injury admission in acute care hospitals (PHAC, 2005) and in Canada; falls are the sixth leading cause of death (RNAO, 2002).
- Fall-related injuries account for $2.9 billion annually among Canadians older adults (DAS, 2007).

There are many risk factors that can lead to you falling. These risk factors include: biological/physical (i.e. advanced age), socio-economic (i.e. low income), behavioural (i.e. lack of exercise), and environmental (i.e. poor building designs) (Scott et al., 2001). Of these risk factors, the most cost-effective and easily modifiable approach in reducing falls is exercise participation. Exercise is effective in preventing falls because it may improve physical function which in turn lowers the physical risk factors associated with falls. For example, balance is a component of physical function and by improving your ability to balance through exercise participation you may reduce the likelihood of falling.

Recently, tai chi has gained popularity for its potential benefits on physical function components such as improved balance. tai chi is an ancient Chinese martial art that emphasizes weight shifting and, awareness of body alignment and coordination. However, there are many styles of tai chi such as Chen, Yang, Wu, and Sun each having its own specific movement. To this date, research has not determined the most beneficial style, nor has it determined:

- Which types of tai chi influences physical function components?
- Does tai chi have an influence on preventing falls?
- Will regular participation in tai chi classes improve my current physical function state and improvements reduce the physical risk factors associated with falls?

WHO IS ELIGIBLE TO PARTICIPATE IN THE STUDY?

You are eligible to participate in the study if:

- You are a male or female 60 years old and above.
- Considered to be healthy which means you are able to cope/manage with everyday activities of daily living with or without assistance.
- You do not have the following conditions: balance disorders such as vertigo or any condition that would cause you to frequently feel dizzy or unsteady, and any form of ataxia (lack of coordinated muscles), which may cause frequent uncoordinated muscle movement.
- You are not under medication (more than three) from a drug class known as benzodiazepines. Your consent to see your medical history will be asked of you.

If you have received this letter but are ineligible to participate in the project because of one of the criteria above, please check the appropriate box on the yellow form included in this package and return it to the main office in the envelope provided. This will make sure that we don't contact you again about participation in this particular study.

WHAT WILL I BE ASKED TO DO?

Please note that the following will be explained in detail during Meeting 1, if you have any questions prior to the meeting you may contact Susan Brown. See below for full contact information.

As a participant you will be asked to do the following:

1. Attend Meeting #1 which serves as an introduction to the research study. It will include the explanation of :
   - this Information Package
   - Yang Style tai chi exercise including how many times a week you are expected to come.
   - benefits of being part of the study and procedures to be followed.
   - all consent forms which will be distributed during the first meeting.

2. Complete all consent forms. Consent forms include a physician's clearance, physical activity readiness questionnaire, your personal approval to participate and, approval to access medication and falls history data.

3. After Meeting #1 and the completion of all consent forms, you asked to attend Meeting #2: pre-assessment. Meeting #2: pre-assessment will consist of physical assessments that resemble Activities of Daily Living (ADL). These assessments include four tests which are:
   A. 30 second chair stand – stand and sit as many times as you can in 30 seconds.
   B. Timed 6 minute walk – a 6 minute walk that will be timed.
   C. Chair sit-and reach – Sit in a chair and reach for your toes.
   D. 8-foot timed up-and-go – Sit in a chair, stand and walk 4 feet and return back to your chair.

Adequate rest will be given between each test. The total length for meeting #2: pre-assessment for each participant will range from <u>20 to 40 minutes</u>.

4. After Meeting #2: pre-assessment, you are invited to Meeting #3: pre-assessment. On this day, the Berg Balance Scale (BBS) will be used for physical assessment. BBS is a physical assessment that goes through 14 everyday activities designed to measure balance and determine your current risk of falling.

Note: You may be asked to volunteer to wear a 'Motion Sensor'. A 'Motion Sensor' monitors/measures where you are in space and how fast you make movements such standing, sitting, and walking. The measurements will be taken before and after the tai chi class which will help gain more information on the effectiveness of the exercise.

5. After the two testing days, you will either participate in:

A) Group 1: Yang Style tai chi exercise – which begins in October and conducted twice a week for a total of 24 classes (12 weeks). The class time will be divided into a 5 minute warm up, 40 minute Yang Style tai chi session, a 10 minute break in-between the session and a 5 minute cool down.

OR

B) Group 2: Waitlist control group – where you will be asked not to participate in any tai chi and wait until January when you will be offered similar classes. However, you will be asked to be available for both pre-assessment and post-assessment dates.

- Both groups are asked to keep a calendar to record the number of times you may experience involuntarily landing a lower level such as on an object, the floor, or the ground, with or without injury. Participants are asked to note an 'X' on the day they have involuntarily landed on the floor.

6. Once Group 1 has completed their exercise classes, all participants are asked to attend post-assessment day 1 and 2. Both post-assessment days will be exactly the same as day 1 and 2 of the pre-assessments. You are also asked to return you calendar on this day. This will be the final meeting in which after all the participants have been assessed, refreshments and a social hour will also take place.

WHAT ARE THE POTENTIAL BENEFITS ASSOCIATED WITH MY PARTICIPATION?

Benefits include improving/maintaining components of physical function such as cardio-respiratory endurance, muscular endurance, muscular strength, flexibility, agility, balance, coordination, speed, power, and body composition. In addition, exercise has been demonstrated to improve quality of life (Vaapio, Salminen, Ojanlatva, & Kivela, 2008) and may reduce the risk of depression (Strawbridge, Deleger, Roberts, & Kaplan, 2002). Also, if you have not participated in tai chi exercises, it may be an opportunity for you to learn a new form of exercise that can be practiced in class and home as well.

You will participate in the first quantitative tai chi related study conducted in Canada and be a part of the first research study to demonstrate whether Yang Style tai chi has an effect on all components of physical function. Your participation is very important because, if Yang Style tai chi proves beneficial in improving components of physical function and/or reducing falls it will aid in promoting and implementing Yang Style tai chi at a community-based level across Canada. As a result, your participation may increase tai chi awareness across Canada and help benefit future older adults.

ARE THERE ANY RISKS ASSOCIATED WITH MY PARTICIPATION?

There are two possible risks involved with participation in this study:
(1) physical risks
(2) psychological

In order to manage the physical risks involved, adequate rest and recovery periods (more than 24 hours) between testing and exercise days will be used. This will help you (1) prevent overuse of fatigued muscles, fatigue injuries and falls, (2) enhance cardio-respiratory function, (3) improve aerobic and functional performance, and (4) promote exercise adherence. However if you have not recovered prior to the start of the next exercise class or testing day, you have every right to stop and not take part allowing yourself every opportunity to rest and recover. To further reduce the physical risks, there will be a 10 minute break during the tai chi class and the intensity will depend on your progression. Also, during testing days, support staff (Kinesiologists from both Villages) will be on site to minimize injury during physical assessments.

If rest and recovery as a form of safeguards are not effective, you have every right to dropout at any time during the study's procedure. It is recommended that you seek aid. Aid will be provided on premises (The Village of Taunton Mills and Humber Heights) as a Registered Nurse and Kinesiologists are available for treatment during the pretest-posttest days as well as during the tai chi classes. If further aid is needed, it is recommended you visit your physician. If you have recovered from a prolonged injury that causes you to dropout but you wish to return, a written consent from your physician, registered nurse or kinesiologists will be needed. Please note that whether you dropout or not, your data will be stored for 5 years in a secure metal cabinet in Dr. Lemonde's office at the university. After the 5 year period your data will be destroyed.

In order to manage the psychological risks you will be ensured that (1) all information and data will be confidential and will remain anonymous through the use of a coding system, (2) results of fall outcomes and physical assessments do not determine overall health, (3) participation within the study displays your proactive approach against the associated decline in physical function and increase risk of falls due to aging, (4) the tai chi classes and physical assessments do not act to harm you, rather it acts to manage/improve your physical function and increase your independence and, (5) the study is not competition-based rather an assessment of the potential improvement in your physical function capabilities. You will be reassured by frequent verbal feedback from the tai chi instructor and Taunton Mills staff.

WHAT HAPPENS IF I WANT TO WITHDRAW FROM THE STUDY?

Your participation is voluntary and you may decide to stop participating in the study at any time by informing any member of the research team or Susan Brown in person, by phone, or by email. **The care you receive now or in the future through this or any other healthcare facility will not be affected by your decision to participate or to withdraw from the study.** You may choose not to perform a certain task for any reason. However, if you choose to withdraw from the study, all data collected will remain with the research team and may potentially be used towards the research. If you do not want your data to be kept after you withdraw, you are asked to make this request in writing, signing off on it and submitting it to a member of the research team.

WHAT PROCEDURES ARE IN PLACE TO ENSURE CONFIDENTIALITY?

The data collected in this study will be kept confidential. Your name will be separated from your questionnaire data and kept in a separate and secured file by one of the research investigators who will keep this information confidential.

WILL I BE COMPENSATED FOR PARTICIPATING IN THE PROJECT?

Participants will not be compensated for their participation in this project.

HOW WILL I LEARN ABOUT THE RESULTS OF THE PROJECT?

A one-page summary of the results will be made available to you upon completion of the study. The results from the study may also be published in a research journal. If you wish, we can provide you with a copy of any or all research articles that are published from this project. If you would like to receive copies of research articles published from this project, please forward your mailing address to Susan Brown at the Research Institute for Aging using the attached form.

In addition, the research team will return to The Village of Taunton Mills and The Village of Humber Heights to share the results of the project, and they will be instrumental in integrating the results of this project into ongoing programming at The Village of Taunton Mills, The Village of Humber Heights and the other Schlegel Seniors Villages.

WHO CAN I CONTACT IF I HAVE QUESTIONS?

If you have any questions about your participation in this project, or about the recruitment process, please contact Susan Brown at the Schlegel-UW Research Institute for Aging:

"Contact"

If you have questions regarding your rights as a participant, please contact:

Ethics and Compliance Officer
University of Ontario Institute of Technology
Phone: 905.721.8668
Email: compliance@uoit.ca

HAS THE PROJECT RECEIVED CLEARANCE FROM A RESEARCH ETHICS BOARD?

Yes, Certificate# 10-008 from University of Ontario Institute of Technology's Research Ethics Board.

REFERENCES

Division of Aging and Seniors. (2007). *An environmental scan of data sources for seniors 'falls in Canada.* Ottawa, ON: Public Works and Government Services Canada.

Public Health Agency of Canada. (2005). *Report on Seniors' Falls in Canada.* Division of Aging and Seniors. Ottawa: Minister of Public Works and Government Services, Canada.

Registered Nursing Association of Ontario (2002). Prevention of falls and fall injuries in the older adult. Toronto, Canada: Registered Nursing Association of Ontario.

Scott, V., Dukeshire, S., Gallagher, E., & Scanlan, A. (2001). A best practice guide for the prevention of falls among seniors living in the community. Health Canada: F/P/T Ministers Responsible for Seniors.

Strawbridge, W., Deleger, S., Roberts, R., & Kaplan, G. (2002). Physical activity reduces the risk of subsequent depression for older adults. *American Journal of Epidemiology*, 156, 328-334.

Vaapio, S., Salminen, M., Ojanlatva, A., & Kivela, S. (2008). Quality of life as an outcome of fall prevention interventions among the aged: systematic review. *European Journal of Public Health,* 19(1), 7-15.

THE NEXT STEPS:

1. Once you have read this information letter, please make a decision about whether or not you would like to participate in the study.

2. Once you have made your decision, please complete the yellow “Participant Interest Form” included in this package, and **return the completed form to the MAIN OFFICE** in the envelope provided. If we have not received your form within 2 weeks, Susan Brown will contact you to answer any questions that you might have about the project.

3. If you would like to receive copies of publications coming out of this project (even if you don’t want to participate!), please complete the green “Request for Publications Form” included in this package, and **return the completed form to the MAIN OFFICE** in the envelope provided.

Schlegel-UW Research Institute for Aging

INTEREST FORM

The Village of Taunton Mills
The Village of Humber Heights

THE EFFECT OF YANG STYLE TAI CHI ON FALL PREVENTION AND PHYSICAL FUNCTION

RESIDENT NAME:____

……………………………………………………………………………………………………

Please select one of the following options after reading the attached information letter:

____ **YES: I would like to participate in this study**

If you select "yes", your name and room number (no other personal information) will be provided to the research team. The research team will then approach you to complete the informed consent process and arrange for participation.

____ **MAYBE: I may participate in the study, but I'd like more information**

.If you select "maybe", Susan Brown (from the RIA) will meet with you to answer any questions you might have. If at that point, you would like to participate in the study, she will give your name and room number (no other personal information) to the research team. The research team will then approach you to complete the informed consent process and arrange for participation. Also there will be a meeting that you will be able to attend for further information, after the meeting you may be able to make your decision.

What is the best way for Susan to reach you?

____ Phone (please provide your phone number: _______________)
____ Email (please provide your email address: _______________)
____ Personal visit

What are the best days/times for Susan to call or visit? (please circle the best options)

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Morning	Morning	Morning	Morning	Morning
Afternoon	Afternoon	Afternoon	Afternoon	Afternoon
Evening	Evening	Evening	Evening	Evening

____ **NO: I do not want to participate in this study**

If you select "no", none of your personal information (i.e. name or room number) will be provided to the research team. If you select "no", you will not be approached again about this particular study, no questions will be asked, and this will in no way affect the care that you receive.

____ **I am not eligible for this study**

If you are not eligible for this study based on one of the criteria listed in the information letter, we apologize for the inconvenience, and you will not be contacted again about your involvement in this project.

____ **Please do not contact me about future research studies**

By selecting this option, you will not be approached again about participating in any future research projects. You will still receive notices about upcoming research presentations or projects that apply to all residents within the Village, but you will not receive information inviting you to participate in individual research projects.

…………………………………………………………………………………………………

SIGNATURE: ___________________________________ DATE: ___________________

If we do not receive your form in two (2) weeks, Susan Brown will contact you to answer any questions that you might have about this process. If you have questions in the meantime, please do not hesitate to contact her by phone **"Contact"**

PLEASE RETURN THIS COMPLETED FORM TO THE MAIN OFFICE IN THE ENVELOPE PROVIDED

Appendix H

Recruitment poster

A poster displayed within the facility to generate interest for the study. *Non-publicized contact information that was displayed has been removed for confidentiality reasons and "contact" has respectively been written in its place.*

The Village of Taunton Mills and the Schlegel-UW Research Institute for Aging

LIFELONG LEARNING PROGRAM

The effect of Yang style Tai Chi on fall prevention and physical function

Presented by:

Dr. Manon Lemonde and Rohan Gonsalves

University of Ontario Institute of Technology

Thursday, November 4, 2010

2:00PM

LOCATION: Theatre Room

This presentation will describe an upcoming research project investigating the effect of a specific type of Tai Chi on fall prevention and physical function.

Join Dr. Manon Lemonde and her graduate student, Rohan Gonsalves as they discuss the importance of physical activity on physical function, and explain what is involved in their upcoming research project.

Following the presentation, you will be given an opportunity to ask questions and/or sign up to participate in the project. Even if you aren't interested in participating in a research project at this time, you are welcome to join us for this presentation.

ALL ARE WELCOME TO ATTEND

Appendix I

Interest letter package distributed during recruitment presentation

Interest Letter package handed out during the presentation. Non-publicized contact information that was displayed has been removed for confidentiality reasons and "contact" has respectively been written in its place.

OAKWOOD RETIREMENT COMMUNITIES INC.

Schlegel-UW RIA RESEARCH INSTITUTE *for* AGING

OPPORTUNITY TO BE INVOLVED IN RESEARCH

Hello everyone:

I wanted to take a moment to let you know about an upcoming research opportunity. **Dr. Manon Lemonde** and **Rohan Gonsalves** (a graduate student) from the **University of Ontario Institute of Technology** will be doing a research project at Taunton Mills investigating the effects of Tai Chi on physical function and fall prevention, beginning in the middle of November. The Schlegel-UW Research Institute for Aging (www.the-ria.ca) is excited to be working with the research team on this very important project.

The purpose of the research project entitled "**The effect of Yang style Tai Chi on physical function and fall prevention**" is to investigate how a <u>specific</u> form of Tai Chi affects <u>all components</u> of physical function (e.g. strength, balance, endurance, etc.) and the individual's risk of falling. Previous research has not examined the effect of a specific form of Tai Chi on function. Instead, the programs delivered have involved a mix of many different forms of Tai Chi, possibly minimizing the positive effects of the exercise due to inconsistency of the style. In addition, while previous research has examined the effect of Tai Chi on a single component of physical function (e.g. effect of Tai Chi on balance alone), this study will take a more comprehensive look at physical function by examining <u>all</u> of its components.

Participation in this research project would involve completing a physical assessment prior to the Tai Chi classes, and then completing the same physical assessment approximately 3 months later (to investigate the effects of the intervention). In the interim, approximately half of the participants would be invited to participate in Tai Chi classes twice a week for 12 weeks, led by a trained Tai Chi specialist (this is the "intervention" group). While the other half of the participants (the "control" group) would not have the opportunity to participate in the Tai Chi classes during the study period, the classes will be offered again following the study period so that everyone who would like to participate will have a chance to do so.

The research team will be coming back to Taunton Mills during the last 2 weeks of November to complete the pre-program physical assessments. The actual Tai Chi classes for those in the intervention group will begin early in December – the days and times are still being sorted out.

In order to be ready for the pre-program physical assessments, I will be coming to The Village of Taunton Mills on **Thursday, November 11, 2010** and **Friday, November 12, 2010** to talk to any residents who express an interest in learning more about the project. During our meeting, I will go over exactly what would be involved in the project, and you will have the opportunity to make a decision about participating. At that time, we will also schedule a pre-program physical assessment appointment at a time that is convenient for both you and the research team.

PLEASE NOTE: EXPRESSING AN INTEREST IN SPEAKING TO ME ABOUT THE PROJECT DOES NOT MEAN THAT YOU MUST PARTICIPATE IN THE PROJECT
This is simply an opportunity for you to learn about the research and ask any questions that you have.

IF, AFTER TALKING TO ME, YOU DO NOT WISH TO PARTICIPATE, YOU WILL BE GIVEN AN OPPORTUNITY TO DECLINE PARTICIPATION, AND NO QUESTIONS WILL BE ASKED.

Please complete the section on the bottom of this page and return it to "Contact" in the envelope provided. If you have any questions about this project or about the recruitment process, please do not hesitate to contact me at any time!

Sincerely,

____

RIA representative

PLEASE FILL OUT THIS SECTION AND RETURN IT TO "Primary Contact" IN THE ENVELOPE PROVIDED

Your name:____

Your room:____

_____ **YES** I am interested in participating in this project. I understand that by checking this box, I am NOT giving my consent to participate in the research project. Instead, I am agreeing to meet with Susan Brown to talk about the project in more specific terms and to make a decision about participating after I've heard all of the details.

_____ **MAYBE** The research sounds interesting, but I am still on the fence. I would like to meet with Susan Brown to talk about the research project and to ask her my questions.

_____ **NO** I am not interested in participating in this project at this time

_____ Please do not contact me about any future research projects

Signature: ___________________________ Date: ______________________

Appendix J

Coded participant template

Table 4

An example of the coded participant template used by the Research Coordinator to develop a coded participant list and as reference for the assessment schedule. Contact information (i.e. name) was not shared with the Investigator

Code	Name
345A	Xx
242B	Xx
234C	Xx
237D	Xx
212E	Xx

Appendix K

Participant informed consent form

Consent form to participate in the research study. Non-publicized contact information that was displayed has been removed for confidentiality reasons and "contact" has respectively been written in its place.

Schlegel-UW RIA Research Institute *for* Aging

INFORMED CONSENT

Schlegel Seniors Villages

THE EFFECT OF YANG STYLE TAI CHI ON FALL PREVENTION AND PHYSICAL FUNCTION

UOIT CHALLENGE INNOVATE CONNECT

Primary Investigator: Dr. Manon Lemonde, PhD
Faculty of Health Sciences
University of Ontario Institute of Technology

Student Investigator: Rohan Gonsalves
Faculty of Health Sciences
University of Ontario Institute of Technology

………

PLEASE NOTE: By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Dr. Manon Lemonde and Rohan Gonsalves from the Faculty of Health Sciences at the University of Ontario Institute of Technology. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted. I am aware that I may withdraw from the study without penalty at any time by advising the researchers of this decision.

My signature below indicates my understanding that:

- It is my responsibility to report any signs or symptoms such as chest pain to the class instructor and my physician
- Participation in this program is voluntary, and I am free to stop at any time but may be asked to give a reason
- The Schlegel-UW Research Institute for Aging and the Schlegel Seniors Villages do not provide compensation for injuries that may occur and if I am accidentally injured during the research process, the instructor will be unable to offer treatment and I may be asked to seek treatment from my own physician or medical staff
- I may be asked to wear a "motion sensor" during all physical testing days
- Any personal information obtained in this study will remain confidential and will not be disclosed to anyone other than the investigators involved. I agree results from this study can be used for research purposes and my name will not be directly associated with any of the results
- I will receive a debriefing letter which summarizes the study only after completion of the written report in Summer 2011

I understand that if I have any questions or concerns resulting from my participation in this study, I may contact "Contact" (Research Coordinator, Schlegel-UW Research Institute for Aging) either by **"contact"**.

This project has been reviewed by, and received ethics clearance through, the Research Ethics Board at the University of Ontario Institute of Technology.

______________________________	______________________________
Participant/legal representative name *(please print)*	Witness name *(please print)*
______________________________	______________________________
Participant/legal representative signature	Witness signature
______________________________	______________________________
Date	Date

Appendix L

Physical Activity Readiness Questionnaire (PAR-Q)

Physical Activity Readiness Questionnaire (PAR-Q) used for a general understanding of participants (below 69 years old) readiness to take part in an exercise program without physicians consent.

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME ______________________________

SIGNATURE ______________________________ DATE ______________________________

SIGNATURE OF PARENT ______________________________ WITNESS ______________________________
or GUARDIAN (for participants under the age of majority)

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

 Supported by: Health Canada Santé Canada

continued on other side...

...continued from other side

PAR-Q & YOU

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

Canada's Physical Activity Guide to Healthy Active Living

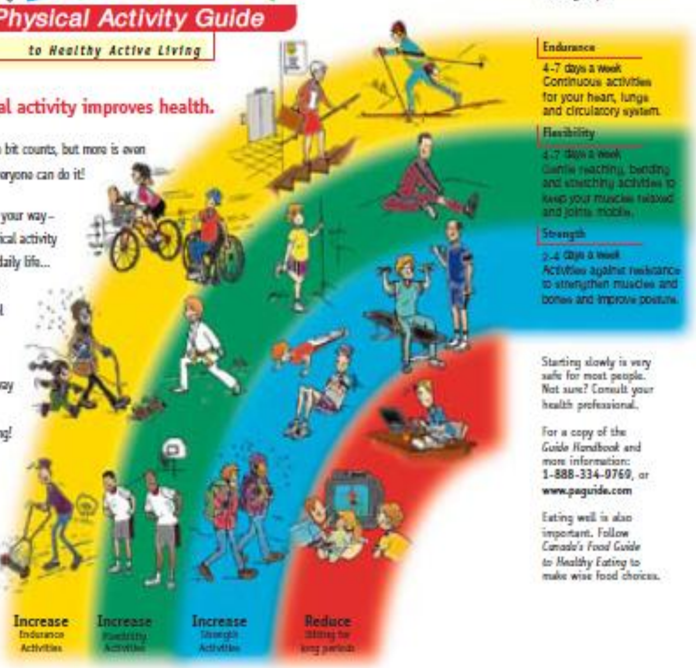
Physical activity improves health.

Every little bit counts, but more is even better – everyone can do it!

Get active your way – build physical activity into your daily life...

- at home
- at school
- at work
- at play
- on the way

...that's active living!



Choose a variety of activities from these three groups:

Starting slowly is very safe for most people. Not sure? Consult your health professional.

For a copy of the *Guide Handbook* and more information: **1-888-334-9769**, or **www.paguide.com**

Eating well is also important. Follow *Canada's Food Guide to Healthy Eating* to make wise food choices.

Get Active Your Way, Every Day—For Life!

Scientists say accumulate 60 minutes of physical activity every day to stay healthy or improve your health. As you progress to moderate activities you can cut down to 30 minutes, 4 days a week. Add-up your activities in periods of at least 10 minutes each. Start slowly... and build up.

Time needed depends on effort

Very Light Effort	Light Effort *60 minutes*	Moderate Effort *30-60 minutes*	Vigorous Effort *20-30 minutes*	Maximum Effort
• Strolling • Dusting	• Light walking • Volleyball • Easy gardening • Stretching	• Brisk walking • Biking • Raking leaves • Swimming • Dancing • Water aerobics	• Aerobics • Jogging • Hockey • Basketball • Fast swimming • Fast dancing	• Sprinting • Racing

Range needed to stay healthy

You Can Do It – Getting started is easier than you think

Physical activity doesn't have to be very hard. Build physical activities into your daily routine.

- Walk whenever you can – get off the bus early, use the stairs instead of the elevator.
- Reduce inactivity for long periods, like watching TV.
- Get up from the couch and stretch and bend for a few minutes every hour.
- Play actively with your kids.
- Choose to walk, wheel or cycle for short trips.
- Start with a 10 minute walk – gradually increase the time.
- Find out about walking and cycling paths nearby and use them.
- Observe a physical activity class to see if you want to try it.
- Try one class to start – you don't have to make a long-term commitment.
- Do the activities you are doing now, more often.

Benefits of regular activity:	Health risks of inactivity:
- better health - improved fitness - better posture and balance - better self-esteem - weight control - stronger muscles and bones - feeling more energetic - relaxation and reduced stress - continued independent living in later life	- premature death - heart disease - obesity - high blood pressure - adult-onset diabetes - osteoporosis - stroke - depression - colon cancer

Health Canada Santé Canada

Canadian Society for Exercise Physiology

Source: Canada's Physical Activity Guide to Healthy Active Living, Health Canada, 1998 http://www.hc-sc.gc.ca/hppb/paguide/pdf/guideEng.pdf

FITNESS AND HEALTH PROFESSIONALS MAY BE INTERESTED IN THE INFORMATION BELOW:

The following companion forms are available for doctors' use by contacting the Canadian Society for Exercise Physiology (address below):

The **Physical Activity Readiness Medical Examination (PARmed-X)** — to be used by doctors with people who answer YES to one or more questions on the PAR-Q.

The **Physical Activity Readiness Medical Examination for Pregnancy (PARmed-X for Pregnancy)** — to be used by doctors with pregnant patients who wish to become more active.

References:

Arraix, G.A., Wigle, D.T., Mao, Y. (1992). Risk Assessment of Physical Activity and Physical Fitness in the Canada Health Survey Follow-Up Study. **J. Clin. Epidemiol.** 45:4 419-428.

Mottola, M., Wolfe, L.A. (1994). Active Living and Pregnancy, In: A. Quinney, L. Gauvin, T. Wall (eds.), **Toward Active Living: Proceedings of the International Conference on Physical Activity, Fitness and Health**. Champaign, IL: Human Kinetics.

PAR-Q Validation Report, British Columbia Ministry of Health, 1978.

Thomas, S., Reading, J., Shephard, R.J. (1992). Revision of the Physical Activity Readiness Questionnaire (PAR-Q). **Can. J. Spt. Sci.** 17:4 338-345.

For more information, please contact the:

Canadian Society for Exercise Physiology
202-185 Somerset Street West
Ottawa, ON K2P 0J2
Tel. 1-877-651-3755 • FAX (613) 234-3565
Online: www.csep.ca

The original PAR-Q was developed by the British Columbia Ministry of Health. It has been revised by an Expert Advisory Committee of the Canadian Society for Exercise Physiology chaired by Dr. N. Gledhill (2002).

Disponible en français sous le titre «Questionnaire sur l'aptitude à l'activité physique - Q-AAP (revisé 2002)».

Supported by: Health Canada Santé Canada

Appendix M

Medical clearance form

Medical clearance form to participate in the research study. Non-publicized contact information that was displayed has been removed for confidentiality reasons and "contact" has respectively been written in its place.

Medical Clearance

Your patient, ___________________________has expressed interest in participating in a research study that investigates Yang Style Tai Chi and its influence on components of physical function and fall prevention. Taunton Mills, a community health centre located in Oshawa, Ontario will the conducting site of research study. The research study includes pre-testing assessments, 3x/ week Tai Chi class (24 classes) and followed by post-testing assessments. Prior to committing to the research study, the program participants are required to complete an informed consent, activity readiness questionnaire (if 69 years old and below), and receive your endorsement of his or her participation.

Assessment

The following will be assessed upon the pre-test and post-test assessment days:

Components of Physical Function	**Assessment**	**Approval (Yes or No)**
Cardiovascular	Six-minute walk	
Muscular Strength and Endurance	30 second chair stand	
Flexibility	Chair sit-and-reach	
Mobility: dynamic balance, speed/agility, coordination and power	8-foot (2.4 metres) timed up-and-go	
Balance	Berg Balance Scale	

Exercise Program:

The exercise program will consist of Yang Style Tai Chi that emphasizes multidirectional weight shifting, and awareness of body alignment and coordination. The intensity of the program is based on the individual capabilities of each participant. The exercise class meets 3x/ week for 60 minutes over 8 week duration. Each class will be instructed by a trained Tai Chi instructor with education and experience in exercise science and aging. The class will consist of a 10-minute warm-up; practice forms of Yang Style Tai Chi; and a 5 to 10-minute cool down.

Exercise class approval: Yes________ No_________

Please call **"contact"** if you have any questions concerning the research study.

Date_____________

Print Name of Medical Practitioner ________________________

Signature of Medical Practitioner _______________________

Appendix N

Assessment schedule template

An example of the assessment schedule template used to book meetings and also allowed the Investigator to know dates/ times of assessments. Names were removed by the Research Coordinator before being sent to the Investigator.

The Effect of Yang Style Tai Chi on Fall Prevention and Physical Function

PRE/POST-PROGRAM ASSESSMENT SIGN-UP SHEET

The pre-program assessments for this project take place over two days (with one day of rest in between). We are hoping to get all of the assessments finished during the week of November 29, although we realize that it might not be possible. We're going to give it our best shot, though! So, please sign up for an assessment time on either Tuesday/Thursday (November 30/December 2), Wednesday/Friday (December 1/December 3) or Tuesday/Thursday (December 7/December 9). Be sure to choose an assessment time on both days! **Assessments will take place in the fitness centre on the long-term care side of the building (the room with the machines past the set of double doors).**

TUESDAY/THURSDAY

WEDNESDAY, DECEMBER 1, 2010		
TIME	NAME	ID CODE
9:30AM		
10:00AM		
10:30AM		
11:00AM		
11:30AM		
☼ LUNCH BREAK ☼		
1:30PM		
2:00PM		
2:30PM		
3:00PM		

FRIDAY, DECEMBER 3, 2010		
TIME	NAME	ID CODE
9:30AM		
10:00AM		
10:30AM		
11:00AM		
11:30AM		
☼ LUNCH BREAK ☼		
1:30PM		
2:00PM		
2:30PM		
3:00PM		

Appendix O

Demographic data sheet

Demographic data sheet used to measure body composition during pre/post assessment day one.

Please complete the following:

153D

Age: ___________

Gender: Male ☐ Female ☐

Weight: ___________ Height: ___________

Use of walking aid:

Calculated BMI:

Appendix P

Classification and level of risk based on Body Mass Index (BMI) scores

Table 5

Classifications and level of risk based of BMI scores provided and summarized by Rikli & Jones (2001), results are calculated by dividing weight in kilograms by height in meters squared (BMI = kg/m²). Full reference may be seen in the reference list

Classification	**MI Category (kg/m^2)**	**Risk of developing health and mobility problems**
Underweight	< 19.0	Increased – At-Risk
Normal Weight	19.0 – 26.0	Least – Normal
Overweight	< 26.0	Increased – At-Risk

Appendix Q

Berg Balance Scale (BBS) form

The Berg Balance Scale form used to assess static and dynamic balance. This form was adapted from Berg, Wood-Dauphinee, Williams, & Maki, 1992. Full reference can be seen in the reference page.

Berg Balance Scale Form

153D

ITEM DESCRIPTION SCORE (0-4)
Sitting to standing ________
Standing unsupported ________
Sitting unsupported ________
Standing to sitting ________
Transfers ________
Standing with eyes closed ________
Standing with feet together ________
Reaching forward with outstretched arm ________
Retrieving object from floor ________
Turning to look behind ________
Turning 360 degrees ________
Placing alternate foot on stool ________
Standing with one foot in front ________
Standing on one foot ________
Total ________

Equipment needed: Ruler, two standard chairs (one with arm rests, one without), footstool or step, stopwatch or wristwatch, 15 ft walkway

Completion:
Time: 15-20 minutes

Scoring: A five-point scale, ranging from 0-4. “0” indicates the lowest level of function and “4” the highest level of function. Total Score = 56

Interpretation:
41-56 = low fall risk
21-40 = medium fall risk
0 –20 = high fall risk

14-item scale:

SITTING TO STANDING INSTRUCTIONS: Please stand up. Try not to use your hand for support.

( ) 4 able to stand without using hands and stabilize independently
( ) 3 able to stand independently using hands
( ) 2 able to stand using hands after several tries
( ) 1 needs minimal aid to stand or stabilize
( ) 0 needs moderate or maximal assist to stand

STANDING UNSUPPORTED INSTRUCTIONS: Please stand for two minutes without holding on.

( ) 4 able to stand safely for 2 minutes
( ) 3 able to stand 2 minutes with supervision
( ) 2 able to stand 30 seconds unsupported
( ) 1 needs several tries to stand 30 seconds unsupported
( ) 0 unable to stand 30 seconds unsupported

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL INSTRUCTIONS: Please sit with arms folded for 2 minutes.

( ) 4 able to sit safely and securely for 2 minutes
( ) 3 able to sit 2 minutes under supervision
( ) 2 able to able to sit 30 seconds
( ) 1 able to sit 10 seconds
( ) 0 unable to sit without support 10 seconds

STANDING TO SITTING INSTRUCTIONS: Please sit down.

( ) 4 sits safely with minimal use of hands
( ) 3 controls descent by using hands
( ) 2 uses back of legs against chair to control descent
( ) 1 sits independently but has uncontrolled descent
( ) 0 needs assist to sit

TRANSFERS INSTRUCTIONS: Arrange chair(s) for pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.

( ) 4 able to transfer safely with minor use of hands
( ) 3 able to transfer safely definite need of hands
( ) 2 able to transfer with verbal cuing and/or supervision
( ) 1 needs one person to assist
( ) 0 needs two people to assist or supervise to be safe

STANDING UNSUPPORTED WITH EYES CLOSED INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.

( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays safely
( ) 0 needs help to keep from falling

STANDING UNSUPPORTED WITH FEET TOGETHER INSTRUCTIONS: Place your feet together and stand without holding on.

( ) 4 able to place feet together independently and stand 1 minute safely
( ) 3 able to place feet together independently and stand 1 minute with supervision
( ) 2 able to place feet together independently but unable to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds

REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at the end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the fingers reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)

( ) 4 can reach forward confidently 25 cm (10 inches)
( ) 3 can reach forward 12 cm (5 inches)
( ) 2 can reach forward 5 cm (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/requires external support

PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION INSTRUCTIONS: Pick up the shoe/slipper, which is in front of your feet.

( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5 cm(1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING INSTRUCTIONS: Turn to look directly behind you over toward the left shoulder. Repeat to the right. (Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.)

( ) 4 looks behind from both sides and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

TURN 360 DEGREES INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cuing
( ) 0 needs assistance while turning

PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.
( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps in > 20 seconds
( ) 2 able to complete 4 steps without aid with supervision
( ) 1 able to complete > 2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try

STANDING UNSUPPORTED ONE FOOT IN FRONT INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width.)

( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds
( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

STANDING ON ONE LEG INSTRUCTIONS: Stand on one leg as long as you can without holding on.

( ) 4 able to lift leg independently and hold > 10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independently and hold L 3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently.
( ) 0 unable to try of needs assist to prevent fall

TOTAL SCORE (Maximum = 56)

Appendix R

Primary outcome measures

Table 6

A summary of each primary outcome measure organized by its target component of physical function and description

Type of Assessment	Targeted component of physical function	Description
BMI	Body composition	Ratio of body weight to height (kg/m^2)
Berg Balance Scale (BBS)	Static and dynamic balance	14-item scale to measure static and dynamic balance based on performance. Performance is then scores based on an ordinal scale from 0-4, 0 being it cannot be performed and 4 being able to perform without assistance. 14-items include performing various ADL
30 second chair sit-and stand (30-SCS)	Lower body muscle strength and endurance	Number of full stands that can be completed in 30 seconds
Chair sit-and reach (CSR)	Lower body flexibility	From a sitting position at the front of the chair, with leg extended and hand reaching towards toe, the number of inches (+ or -) between extended middle finger and tip of toe is measured
8-foot timed up-and go (TUG)	Dynamic balance, coordination, speed/agility, and power	Number of seconds required to get up from a seated position, walk 8 feet, turn, and return to a seated position
Timed 6 minute walk (6MW)	Aerobic endurance	Number of yards that can be walked in a 50 yard course within 6 minutes

Appendix S

Normative performance standards

Table 7a

Normative performance standards for Women as per C.J. Jones & R. E. Rikli, 2001, p.87. Copyright 2001 by Human Kinetics

	Age (women)*						
Test	**60-64**	**65-69**	**70-74**	**75-79**	**80-84**	**85-89**	**90-94**
30-SCS (# of stands)	12-17	11-16	10-15	10-15	9-14	8-13	4-11
CSR (inches +/-)	-0.5- +5.0	-0.5- +4.5	-1.0- +4.0	-1.5- +3.5	-2.0- +3.0	-2.5- +2.5	-4.5- +1.0
TUG (sec)	6.0-4.4	6.4-4.8	7.1-4.9	7.4-5.2	8.7-5.7	9.6-6.2	11.5-7.3
6MW*** (# or yards)	545-660	500-635	480-615	435-585	385-540	340-510	275-440

**Normal range of scores is defined as the middle 50 percent of each age group. Scores above the range would be considered "above average" for the age group and those below the range would be "below average".*
***Scores are rounded to the nearest half-inch.*
****Scores are rounded to the nearest five yards*

Table 7b

Normative performance standards for Men as per C.J. Jones & R. E. Rikli, 2001, p.87. Copyright 2001 by Human Kinetics

	Age (men)						
Test	**60-64**	**65-69**	**70-74**	**75-79**	**80-84**	**85-89**	**90-94**
30-SCS (# of stands)	14-19	12-18	12-17	11-17	10-15	8-14	7-12
CSR (inches +/-)	-2.5- +4.0	-3.0- +3.0	-3.0- +3.0	-4.0- +2.0	-5.5- +1.5	-5.5- +0.5	-6.5- - 0.5
TUG (sec)	5.6-3.8	5.9-4.3	6.2-4.4	7.2-4.6	7.6-5.2	8.9-5.5	10.0-6.2
6MW** (# or yards)	610-735	560-700	545-680	470-640	445-605	380-570	305-500

**Normal range of scores is defined as the middle 50 percent of each age group. Scores above the range would be considered "above average" for the age group and those below the range would be "below average".*
***Scores are rounded to the nearest half-inch.*
****Scores are rounded to the nearest five yards*

Appendix T

Criterion-referenced standards

Figure 10a. Criterion-referenced standards for 30-SCS as per R. E. Rikli & C. J. Jones, 2001, p.134. Copyright 2001 by Human Kinetics.

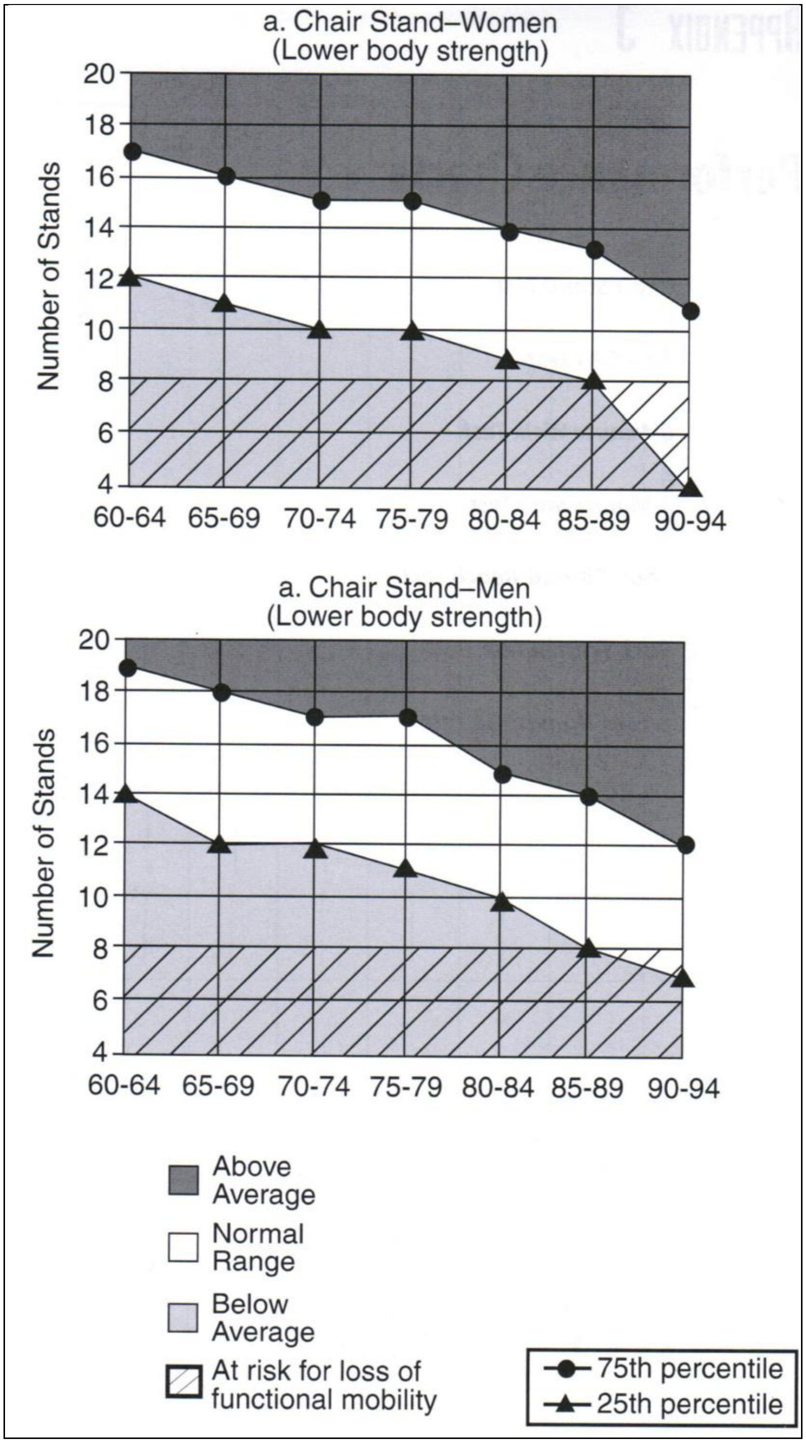


Figure 10b. Criterion-referenced standards for CSR as per R. E. Rikli & C. J. Jones, 2001, p.138. Copyright 2001 by Human Kinetics.

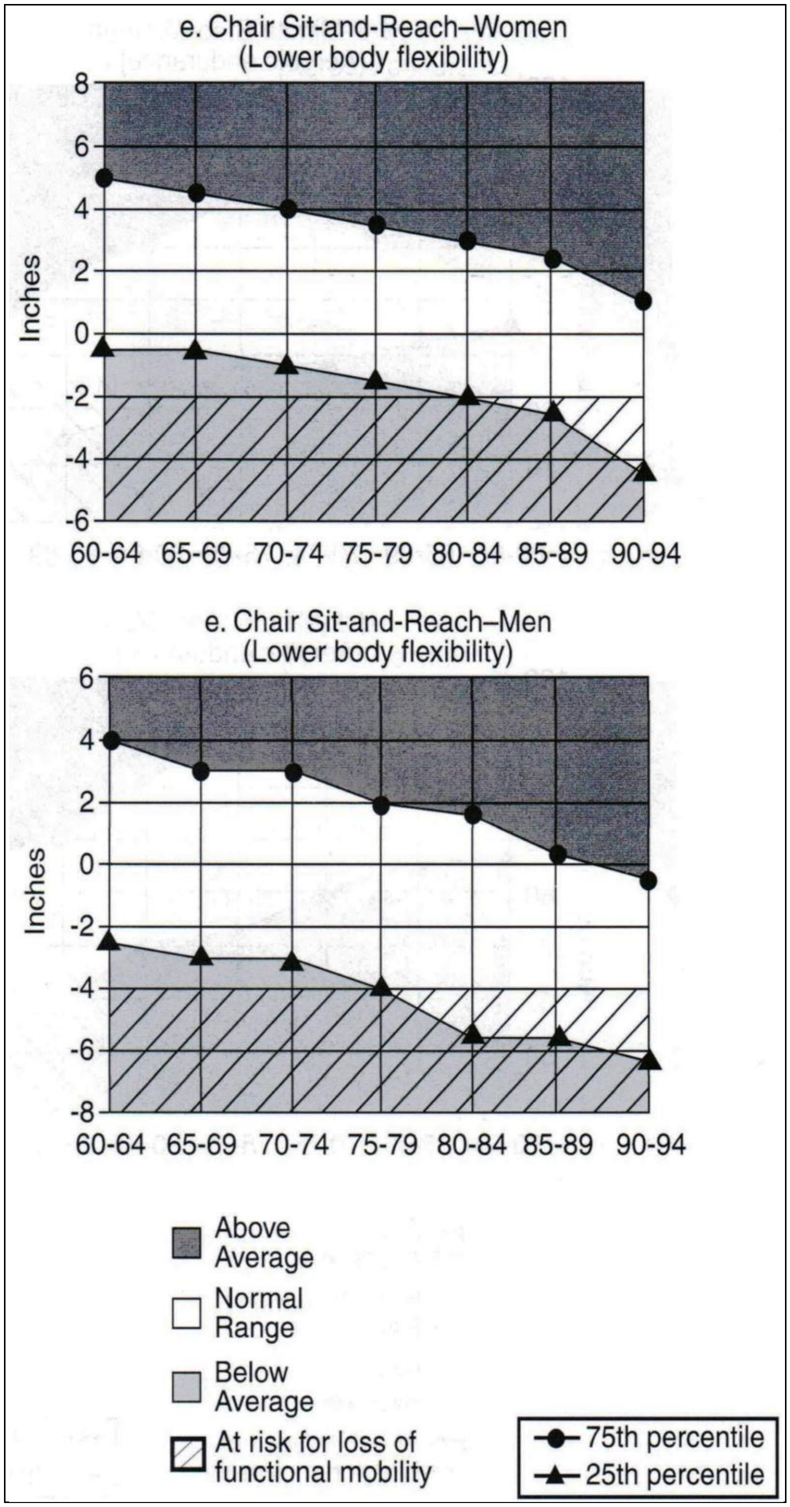


Figure 10c. Criterion-referenced standards for TUG as per R. E. Rikli & C. J. Jones, 2001, p.140. Copyright 2001 by Human Kinetics.

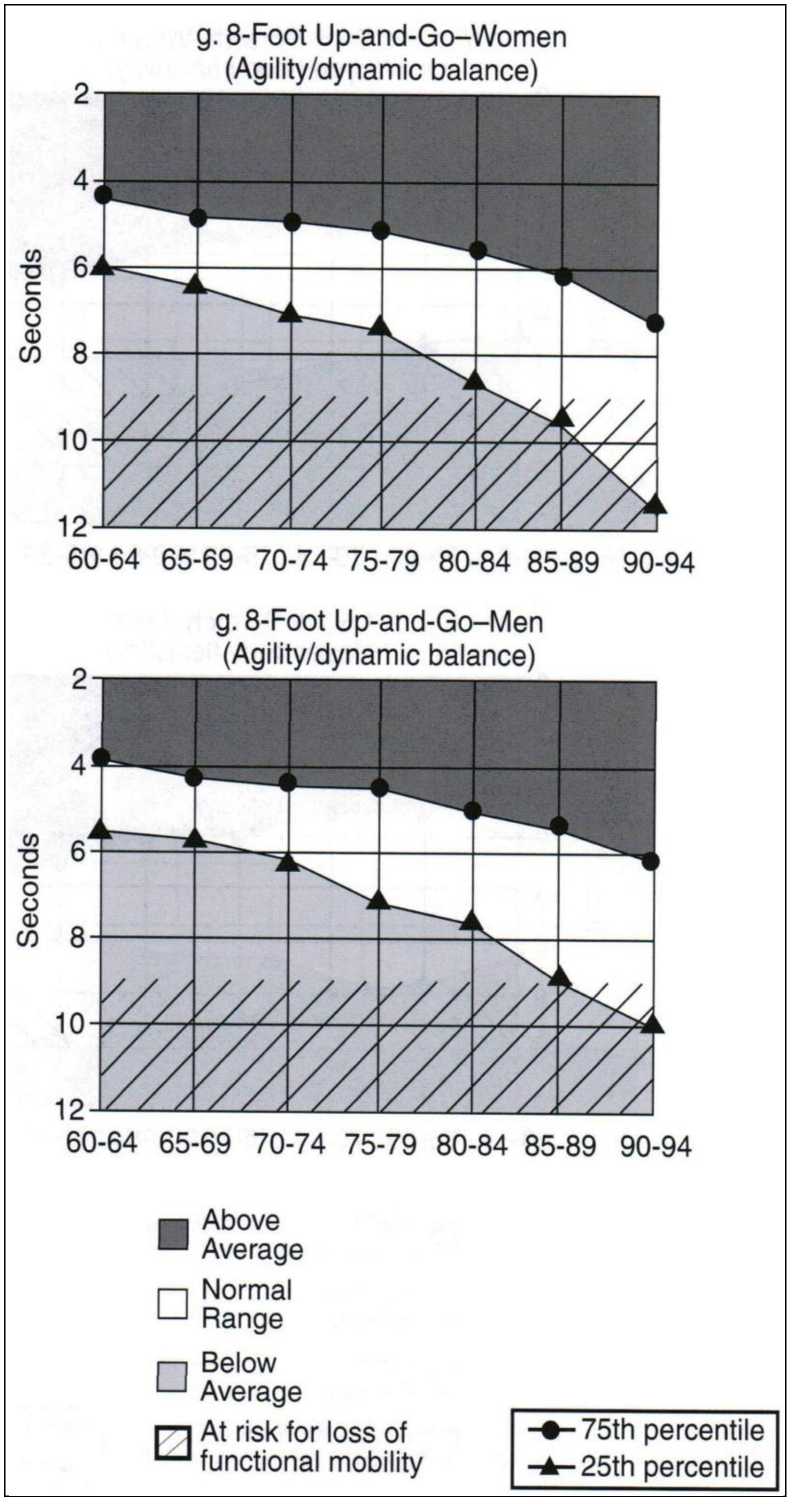
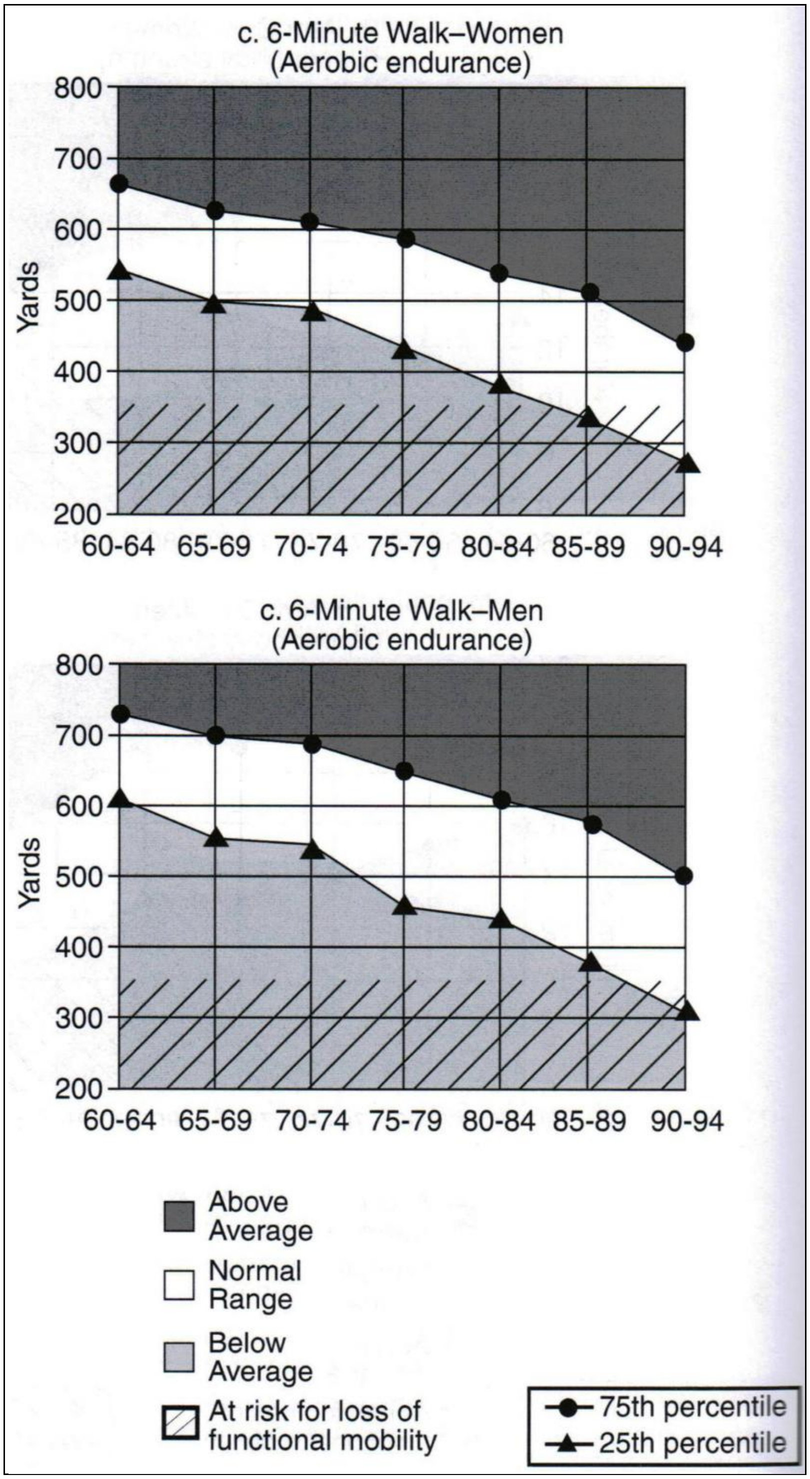


Figure 10d. Criterion-referenced standards for 6MW as per R. E. Rikli & C. J. Jones, 2001, p.136. Copyright 2001 by Human Kinetics.



Appendix U

Falls calendar

A page out of the calendar used by participants to record and describe fall incidences. Non-publicized contact information that was displayed has been removed for confidentiality reasons and "contact" has respectively been written in its place.

DECEMBER 2010

A FALL IS INVOLUNTARILY LANDING ON A LOWER SURFACE OR OBJECT WHICH INCLUDES SLIPPING AND LANDING ON A LOWER SUFACE

Please indicate if you experienced a fall or near fall by marking the calendar with an 'X' on the specific date.

Please describe the fall or near fall on the last page of this booklet.

Please note the dates of the Tai Chi classes.

If you have any questions regarding the calendar or have misplaced it and need a new one please call "Contact"

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10 Tai Chi Class 1	11
12	13 Tai Chi Class 2	14	15 Tai Chi Class 3	16	17 Tai Chi Class 4	18
19	20 Tai Chi Class 5	21	22 Tai Chi Class 6	23	24 No class	25
26	27 Tai Chi Class 7	28	29 Tai Chi Class 8	30	31 Tai Chi Class 9	

Appendix V

Falls incident report

Falls incident report used by residents of Taunton Mills to record experienced falls.

Functional Abilities Program

FALLS INCIDENT REPORT

The Village of Taunton Mills

Modified: November 9, 2010 (sgbrown)

Management Initials (DNC/GM): ______________________ ☐ CIS required and completed

THIS SECTION TO BE COMPLETED BY THE INDIVIDUAL WHO DISCOVERED THE FALL

Name of resident: ______________________
Date of fall (DD/MM/YY): ______________________
Time of fall (24-hr clock): ______________________
Time of discovery (24-hr clock): ______________________

LOCATION

Where does the resident live?

☐ LTC: Claremont ☐ LTC: Dryden ☐ LTC: Dunlop ☐ LTC: Perry
☐ RH: Main floor ☐ RH: ACF ☐ RH: 3rd floor apts. ☐ RH: Independent apts.

Where did the resident fall?

☐ Unknown ☐ Lounge ☐ Hall
☐ Activity room ☐ Bedroom ☐ Bathroom
☐ Dining room ☐ Tub room ☐ Other: ______________

MOBILITY

What is the resident's usual ambulatory status?

☐ Independent (no assistance) ☐ Walker ☐ Electric wheelchair
☐ Cane ☐ Manual wheelchair ☐ Scooter

Was the resident using the appropriate assistive device at the time of the fall?

☐ Yes
☐ No Please explain: ______________________

ACTIVITY

What was the resident doing at the time of the fall?

☐ Unknown ☐ Walking ☐ Transfer (sit ←→ stand)
☐ Reaching ☐ Turning ☐ Sitting
☐ Standing ☐ Lying down ☐ Other: ______________

Was the fall witnessed?

☐ Yes Names of witnesses: ______________________
☐ No

What did the resident or witness say happened OR what did you see or find?

____
____

Was the activity performed...

☐ Independently (i.e. resident fell on his/her own) ☐ Assisted (i.e. resident fell with the assistance of another person ☐ Unknown (i.e. no one can tell you how the fall happened)

EMOTION

What was the resident's emotional state *BEFORE* the fall? (check *ALL* that apply)

☐ Unknown ☐ Aggressive ☐ Agitated
☐ Alert ☐ Angry ☐ Anxious
☐ Calm ☐ Confused ☐ Depressed
☐ Sleepy ☐ Other: ______________

Section completed by: ______________________ Date and time: ______________________

PLEASE GIVE THIS COMPLETED SECTION TO A REGISTERED STAFF MEMBER ASAP TO COMPLETE THE REMAINDER OF THE INCIDENT REPORT

Appendix W

Consent to access falls registry database

A consent form to access the falls registry used to record injurious falls. Non-publicized contact information that was displayed has been removed for confidentiality reasons and "contact" has respectively been written in its place.

CONSENT TO RELEASE INFORMATION FROM THE FALLS REGISTRY

THE EFFECT OF YANG STYLE TAI CHI ON FALL PREVENTION AND PHYSICAL FUNCTION

Principal Investigator: **Rohan Gonsalves, CK** Faculty of Health Sciences
University of Ontario Institute of Technology

Faculty Supervisor: **Dr. Manon Lemonde, PhD** Faculty of Health Sciences
University of Ontario Institute of Technology

………

PLEASE NOTE: By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Rohan Gonsalves and Dr. Manon Lemonde from the Faculty of Health Sciences at the University of Ontario Institute of Technology. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted. I am aware that I may withdraw from the study without penalty at any time by advising the researchers of this decision. **As part of this project, I am aware that the researchers require knowledge of any falls I have sustained or will sustain during the course of this project.**

I agree, of my own free will, to release information about my falls history that is stored in the Functional Abilities Program Falls Registry directly to the researchers, understanding that:

- At no time will any details of my falls history be disclosed to anyone outside of the aforementioned project
- Information about my falls history will be used strictly for research
- My name will be kept confidential in presentations resulting from data gathered for this research project

I understand that if I have any questions or concerns resulting from my participation in this study, I may contact Susan Brown at **"contact"**

This project has been reviewed by, and received ethics clearance through, the Research Ethics Board at the University of Ontario Institute of Technology.

________________________________	________________________________
Participant/legal representative name *(please print)*	Witness name *(please print)*
________________________________	________________________________
Participant/legal representative signature	Witness signature
________________________________	________________________________
Date	Date

Appendix X

Consent to access medication list

A consent form to access participant's medication list to ensure fall incidences did not occur as a result of added benzodiazepines during the intervention. Non-publicized contact information that was displayed has been removed for confidentiality reasons and "contact" has respectively been written in its place.

CONSENT TO RELEASE MEDICATION LIST

THE EFFECT OF YANG STYLE TAI CHI ON FALL PREVENTION AND PHYSICAL FUNCTION

Principal Investigator: Rohan Gonsalves, CK Faculty of Health Sciences
University of Ontario Institute of Technology

Faculty Supervisor: Dr. Manon Lemonde, PhD Faculty of Health Sciences
University of Ontario Institute of Technology

……

PLEASE NOTE: By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Rohan Gonsalves and Dr. Manon Lemonde from the Faculty of Health Sciences at the University of Ontario Institute of Technology. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted. I am aware that I may withdraw from the study without penalty at any time by advising the researchers of this decision. **As part of this project, I am aware that the researchers of require knowledge of the number and types of medications that I am currently taking.**

I agree, of my own free will, to release my current list of medication that is held by the Schlegel Seniors Villages directly to the researchers, understanding that:

- At no time will the list of medications be disclosed to anyone outside of the aforementioned project
- Information obtained from my medication list will be used strictly for research
- My name will be kept confidential in presentations resulting from data gathered for this research project

I understand that if I have any questions or concerns resulting from my participation in this study, I may contact Susan Brown at **"contact"**

This project has been reviewed by, and received ethics clearance through, the Research Ethics Board at the University of Ontario Institute of Technology.

____
Participant/legal representative name
(please print)

____
Witness name
(please print)

____
Participant/legal representative signature

____
Witness signature

____
Date

____
Date

Appendix Y

Attendance list sheets

An example of the attendance sheets used during each class. The purpose was to record attendance and to serve as a way to determine reasons for non-compliance.

FIRST NAME	LAST NAME	DATE

Appendix Z

108 forms of Yang style tai chi

A list provided by the tai chi Instructor of the 108 forms practices for Yang style tai chi.

108 forms or movements practices of yang style tai chi					
1	Commencement of tai chi	37	Seperation right foot kick	73	Wave hands as clouds (7)
2	Left grasp bird's tail	38	Seperation left foot kick	74	Single whip
3	Grasp bird's tail	39	Turn and left heel kick	75	Snake creeps down
4	Single whip	40	Brush knee and twist step (L)	76	Golden cock stands on one leg
5	Step-up and Raise hands	41	Brush knee and twist step (R)	77	Repluse Monkey (R)
6	Stork cools wings	42	Step-up and punch low	78	Repluse Monkey (L)
7	brush knee	43	Turn and chop with fist	79	Repluse Monkey (R)
8	Play the peipa	44	Step-up, Deflect, parry and Punch	80	Slanting flying
9	Brush knee and twist step (L)	45	Right heel kick	81	Step-up and Raise hands
10	Brush knee and twist step (R)	46	Hit tiger left	82	Stork cools wings
11	Brush knee	47	Hit tiger right	83	Brush knee
12	Play the peipa	48	Right heel kick	84	Needle at sea bottom
13	Brush knee and twist step (L)	49	Striek ears with fists	85	Fan though back
14	Chop with fist	50	Left heel kick	86	Turn/white snake puts out tongue
15	Step-up, Deflect, parry and Punch	51	Turn and right heel kick	87	Step-up, Deflect, parry and Punch
16	Apparent close-up	52	Chop and fist	88	Step-up to grasp birds tail
17	Cross Hands	53	Step-up, Deflect, parry and Punch	89	Single whip
18	Carry tiger to mountain	54	Apparent close-up	90	Wave hands as clouds (3)
19	Diagonal single whip	55	Cross hands	91	Single whip
20	Fist under elbow	56	Carry tiger to mountain	92	High pat on horse
21	Repluse Monkey (R)	57	Horizontal single whip	93	Cross hands to penetrate palm
22	Repluse Monkey (L)	58	Parting wild horse's mane (R)	94	Turn, cross hands and kick
23	Repluse Monkey (R)	59	Parting wild horse's mane (L)	95	Chop with fist
24	Slanting flying	60	Parting wild horse's mane (R)	96	Step-up, Deflect, parry and Punch
25	Step-up and Raise hands	61	Parting wild horse's mane (L)	97	Step-up to grasp birds tail
26	Stork cools wings	62	Parting wild horse's mane (R)	98	Single whip
27	Brush knee	63	Left grasp bird's tail	99	Snake creeps down
28	Needle at sea bottom	64	Grasp bird's tail	100	Step-up to form "seven stars"
29	Fan though back	65	Single whip	101	Retreat to ride riger
30	Turn and chop with fist	66	Fair lady works at shuttle (L)	102	Tunr and sweep lotus
31	Step-up, Deflect, parry and Punch	67	Fair lady works at shuttle (R)	103	Shoot tiger with bow
32	Step-up to grasp birds tail	68	Fair lady works at shuttle (L)	104	Chop with fist
33	Single whip	69	Fair lady works at shuttle (R)	105	Step-up, Deflect, parry and Punch
34	Wave hands as clouds (5)	70	Left grasp bird's tail	106	Apparent close-up
35	Single whip	71	Grasp bird's tail	107	Cross hands
36	High pat on horse	72	Single whip	108	Conclusion of tai chi

Appendix AA

6 guiding principles of tai chi provided by Canadian Tai Chi Academy

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Principles of Tai Chi

1. Stepping to 45 degrees

All full length forward steps are to the 45 degrees. This is the position of most strength and flexibility. Also, when transferring the weight to the front leg and then to the back leg, the spine moves in a straight line and does not torque. As you transfer your weight to the front leg when stepping to the 45, the front leg from knee to ankle should be perpendicular to the ground so that your weight is supported by your lower leg.

2. Position of Hips (called "Squaring" the Hips)

As you transfer your weight to the front leg when stepping to the 45, your shoulders and hips should face the direction of the weight-bearing forward foot. As you transfer your weight to the back foot, your shoulders and hips should face the direction of the weight bearing back foot. Transferring the weight forward and back creates more flexibility in the spine, opens the hips joints and strengthens the legs.

3. Diagonal Straight Line from Head to Heel

As you transfer your weight to the front leg when stepping to the 45, position your back in such a way that there is diagonal straight line from the head to the back heel. The diagonal line emphasizes strength to hold the body upright.

4. Equal and Opposite Forces – Hands are Alive

In all the moves, there is energy in both hands so that both are alive all the time. A push with one hand should be matched by an equal push with the other hand which also an even stretch for shoulders, wrists and finger joints.

5. Movement Up and Down

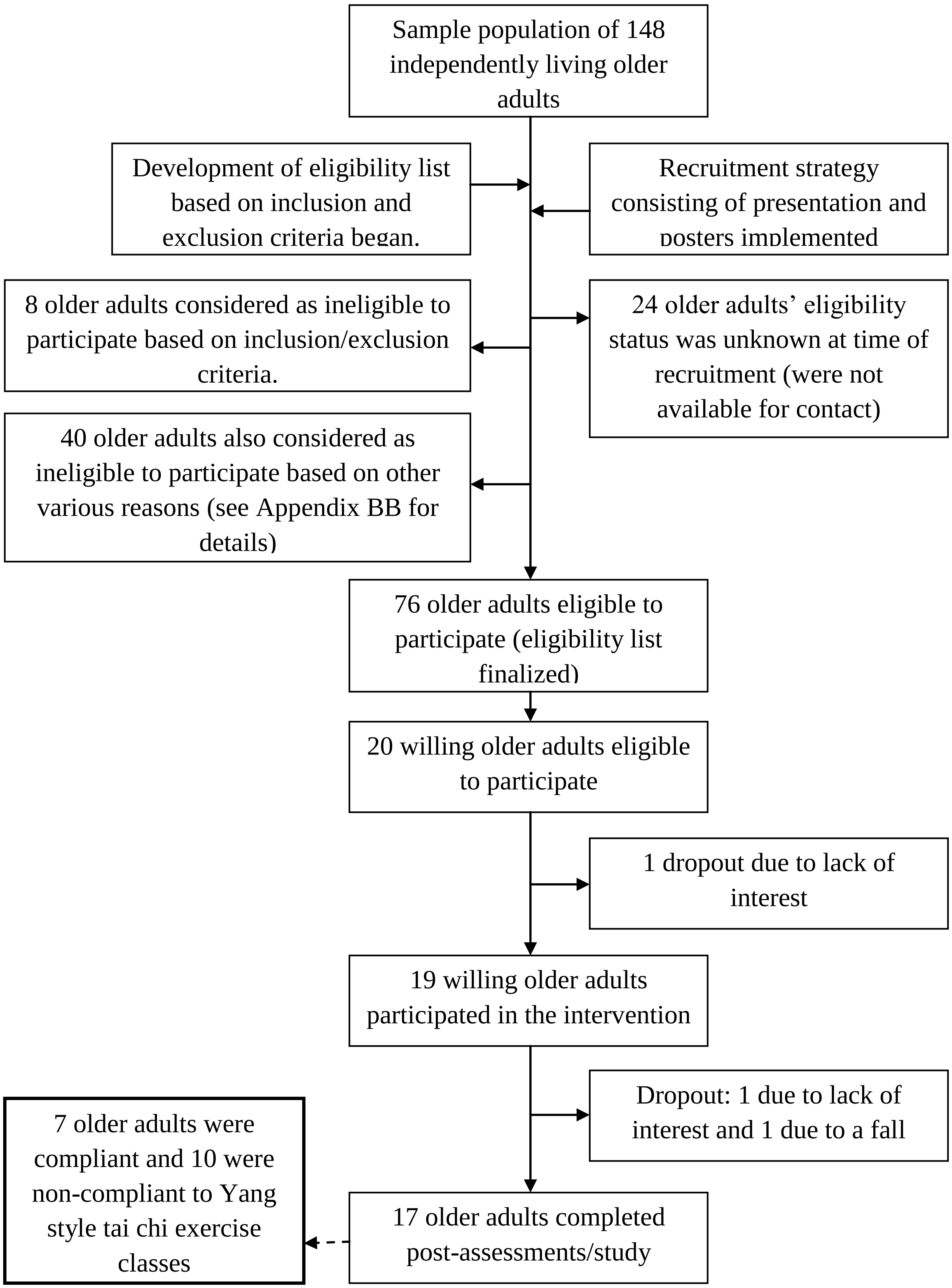
As you progress through the set, you are constantly moving up and down, stretching up and relaxing back down. This provides a complete stretch for the body.

6. Roundness

All moves have roundness and quality to them where you can imagine yourself inside a large ball and with every movement you touch part of that ball with head, arms and/or feet. Roundness will not allow for joints to lock.

Appendix BB

Figure 13. Step-by-step flow chart outlining number of participants during the study.



Appendix CC

Individual results of outcome measure assessments and performance score

Table 13a

Individual results of outcome measure assessments (30-SCS, CSR, TUG, 6MW) and performance score (Above Average-A, Normal-N, Below Average-B, and Loss of physical function-L) before exposure to Yang style tai chi exercise. Results in parenthesis. Note: BMI scores are considered as underweight which is below-U, healthy weight-N and overweight which is above-O

Participant	Gender	Age	Compliant (C) or non-compliant (NC)	BMI (range score)	30-SCS (range score)	CSR (range score)	TUG (range score)	6MW (range score)
WER1	Female	88	NC	31.3 (O)	12 (N)	-5 (L)	21.38 (L)	223 (L)
UHT12	Male	82	NC	30.1 (O)	4 (L)	-13 (L)	32.13 (L)	80 (L)
OUN13	Female	73	NC	29.7 (O)	6 (L)	3 (N)	14.61 (L)	438 (B)
OTI14	Male	90	NC	27 (O)	8 (N)	0 (A)	11.84 (L)	256 (B)
RTY8	Female	85	NC	23.5 (N)	13 (N)	0 (N)	13.3 (L)	301 (B)
JYT9	Female	84	NC	29.1 (O)	5 (L)	-1 (N)	18.34 (L)	104 (L)
JWR10	Male	79	NC	31.6 (O)	7 (L)	2.5 (A)	15.14 (L)	266 (L)
ERT17	Male	91	NC	21.7 (N)	7 (L)	-6.5 (L)	19.08 (L)	353 (N)
GRF18	Male	84	NC	25.5 (N)	3 (L)	-7 (L)	28.13 (L)	90 (L)
LIK19	Female	65	NC	25.6 (N)	4 (L)	-6.5 (L)	15.13 (L)	344 (L)
ASD2	Female	83	C	23 (N)	12 (N)	3 (N)	8.36 (N)	622 (A)
AWE3	Male	85	C	23.4 (N)	13 (N)	2 (N)	7.91 (N)	622 (A)
AFS4	Female	76	C	19.5 (N)	11 (N)	2 (N)	10.11 (L)	425 (B)
FRA5	Female	88	C	24 (N)	7 (L)	-4 (L)	13.51 (L)	315 (B)
OIU11	Female	87	C	24.4 (N)	6 (L)	-2 (N)	14.86 (L)	425 (N)
ORJ15	Male	86	C	26 (N)	13 (N)	2 (A)	9.18 (B/L)	475 (N)
HTR16	Female	82	C	24.9 (N)	9 (N)	5.5 (A)	11.04 (L)	497 (N)

Table 13b

Individual results of outcome measure assessments (30-SCS, CSR, TUG, 6MW) and performance score (Above Average-A, Normal-N, Below Average-B, and Loss of physical function-L) after exposure to Yang style tai chi exercise. Results in parenthesis. Note: BMI scores are considered as underweight which is below-U, healthy weight-N and overweight which is above-O

Participant	Gender	Age	Compliant (C) or non-compliant (NC)	BMI (range score)	30-SCS (range score)	CSR (range score)	TUG (range score)	6MW (range score)
WER1	Female	89	NC	31 (O)	9 (N)	-3.5 (L)	11.38 (L)	108 (L)
UHT12	Male	82	NC	30.1 (O)	1 (L)	-15 (L)	47.34 (L)	226 (L)
OUN13	Female	73	NC	30.6 (O)	13 (N)	3 (N)	10.37 (L)	355 (B)
OTI14	Male	90	NC	27.3 (O)	6 (L)	0 (A)	16.11 (L)	336 (N/L)
RTY8	Female	85	NC	24.5 (N)	12 (N)	0 (N)	13.18 (L)	299 (L)
JYT9	Female	84	NC	28.2 (O)	8 (B)	-5 (L)	12.16 (L)	100 (L)
JWR10	Male	79	NC	31 (O)	10 (B)	2.5 (A)	13.38 (L)	238 (L)
ERT17	Male	91	NC	23 (N)	8 (N)	-3.5 (L)	10.89 (L)	354 (N)
GRF18	Male	84	NC	25.8 (N)	2 (L)	-7 (L)	31.47 (L)	85 (L)
LIK19	Female	65	NC	26.7 (O)	11 (N)	-2.5 (L)	8.38 (B)	238 (L)
ASD2	Female	83	C	24.5 (N)	15 (A)	3 (N)	6.37 (N)	506 (N)
AWE3	Male	85	C	24 (N)	15 (A)	3 (A)	6.26 (N)	506 (N)
AFS4	Female	77	C	19.5 (N)	14 (N)	1.5 (N)	8.2 (B)	399 (B)
FRA5	Female	89	C	24.9 (N)	10 (N)	-3 (L)	12.65 (L)	225 (L)
OIU11	Female	87	C	24 (N)	7 (L)	1 (N)	13.1 (L)	376 (N)
ORJ15	Male	86	C	25.7 (N)	18 (A)	0 (N)	6.22 (N)	498 (N)
HTR16	Female	83	C	25.6 (N)	11 (N)	5.5 (A)	8.99 (N/B)	429 (N)

Appendix DD

Individual results of Berg Balance Scale (BBS) scores

Table 14a

Results of BBS scores that were measured before (pre-test) and after (post-test) exposure to Yang style tai chi exercise among those that were compliant

	Pre-test		Post-test	
		Compliant		
Participant	**Score**	**Fall risk**	**Score**	**Fall risk**
ASD2	54	Low	56	Low
AWE3	55	Low	56	Low
AFS4	51	Low	55	Low
FRA5	34	Medium	45	Low
OIU11	49	Low	49	Low
ORJ15	51	Low	54	Low
HTR16	54	Low	49	Low
Total (average)	50	Low	52	Low

Table 14b

Results of BBS scores that were measured before (pre-test) and after (post-test) exposure to Yang style tai chi exercise among those that were non-compliant

	Pre-test		**Post-test**	
	Non-complaint			
Participant	**Score**	**Fall risk**	**Score**	**Fall risk**
WER1	30	Medium	40	Medium
RTY8	33	Medium	28	Medium
JYT9	30	Medium	26	Medium
JWR10	37	Medium	28	Medium
UHT12	33	Medium	20	High
OUN13	51	Low	43	Low
OTI14	41	Low	48	Low
ERT17	46	Low	39	Medium
GRF18	30	Medium	15	High
LIK19	42	Low	48	Low
Total (average)	37	Medium	34	Medium